5200 SYSTEM CONTROLLER MANUAL

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1.0 GENERAL INFORMATION

This Thermotron instruction manual is dedicated to assisting the reader-user toward a better understanding of the Thermotron 5200 Controller System. Most instruction manuals are seldom read except in time of crisis when equipment malfunction is suspected. When this happens, the manual is usually missing, or, at best, difficult to locate. So, to start things off on the right foot, WHY NOT FIND A CONVENIENT SPOT TO KEEP THIS MANUAL?

We, at Thermotron, have tried to produce a usuable manual. But, being human, we are subject to the frailties of human behavior. Therefore, should you discover any errors or omissions, or should you wish to contribute any recommendations, send us your comments. We, at Thermotron, will be most appreciative.

WARRANTY VOID IF MAINTENANCE

IS PERFORMED WITHOUT AUTHORIZATION

INSPECTION INSTRUCTIONS

After unpacking and removing the controller, check the packing slip to insure a complete shipment. If the shipment is not complete contact Thermotron at once. Check for damage. If damage is apparent, notify the shipping agent immediately.

THE 5200 CONTROLLER

The 5200 controller system is a PROPORTIONAL-INTEGRAL Controller (PI) which provides analog simplicity along with digital accuracy and flexibility. It can be a stand-alone bidirectional controller with a local set point, or it can be used in conjunction with a set point programmer or supervisory computer via the optional RS-232 or GPIB interfaces. Digital display is provided on an optional 4½ digit L.C.D. display panel. The 5200 can be configured to meet applications with many sensor input and control output possibilities.

2.0 MODEL NUMBER

The 5200 Controller Model number is described below. 635200 is the basic model number. Compare your model number with the tables below to identify your features.

635200 - A - B - C - D - E

A. Input Types

1. Type T T/C
2. Type K T/C
3. Type J T/C
4. RTD alpha = .00385
5. RTD alpha = .00392
6. Voltage
7. Current

B. Input Range

1.	-87°to +191°C	-125°to +375°F
2.	-73°to + 93°C	- 99°to +199°F
3.	-87°to +218°C	-125 to +424°F
4.	+ 0°to +100°C	+ 32°to +212°F
5.	+ 0 to + 5 volts	
6.	+ 1 to + 5 volts	
7.	+ 0 to + 1 volts	
8.	+ 0 to +100 millivolts	
9.	+ 4 to + 20 milliamps	
10.	+ 0 to + 20 milliamps	
11.	+ 0 to + 1 milliamps	
12.	-18 to +204°C	+0 to +400°F

C. Output Range Heat

X.	Time proportioning (standard)	
1.	+ 0 to + 5 volts	*
2.	+ 1 to + 5 volts	*
3.	+ 0 to +20 milliamps	*
4.	+ 4 to +20 milliamps	*

D. Output Range Cool

X.	Time proportioning (standard)	
1.	+ 0 to + 5 volts	*
2.	+ 1 to + 5 volts	*
3.	+ 0 to +20 milliamps	*
4.	+ 4 to +20 milliamps	*

E. Options

1. Analog outputs
2. GPIB I/O with analog outputs
3. Serial (RS232) I/O with analog outputs
4. Display panel
5. Unidirectional control (STD. Prods.)

NOTE: * items in C, and D,) require one of options 1, 2, or 3.

Ordering Example: 635200 - 1 - 1 - 1 - 4 - 2, 4

This is a 5200 system with type T T/C, - 125°to +375°F range, 0 to 5 volts heat output throttle, 4 to 20 milliamp cool throttle (time proportioning single stage outputs for heat and cool are standard), GPIB I/O with analog outputs, and the display panel option.

Ordering Exmaple: 634200 - 1 - 2 - X - X - 4

This is a 5200 system with type T T/c, -73°to +93°C range, no analog output options or I/O options, but it does have the display panel option.

3.0 SPECIFICATIONS

-Input Sensor:	Type "T" Thermocouple Type "K" Thermocouple Type "J" Thermocouple RTD Alpha = .00385 RTD Alpha = .00392 Voltage Current
-Input Impedance:	Greater than 10 megohms
-Open Sense Protect:	Turns off SSR common Generates input overscale condition
*-Ranges:	-73°to + 93°C - 99°to +199°F -87°to 191°C -125°to +375°F (standard) -87°to 218°C -125°to +424°F + 0 to +100 C + 32 to +212 F + 0 to + 5 Volts + 1 to + 5 Volts + 0 to + 1 Volts + 0 to +100 mV + 4 to + 20 mA + 0 to + 20 mA
-Measuring Accuracy:	0.1% of span typical, 0.5% guaranteed
**-Proportional Band:	Adjustable from 0 to 50% of span Independant adjustments for heat and cool
-Time Proportioning:	Adjustable from 0.3 to 20 seconds Independant adjustments for heat and cool
-Automatic Reset:	Adjustable from 20 sec/reset to 480 Sec/reset (from 3 to .125 resets/sec) Can also be turned off
-Operating Temp. Range:	0° to 50° C / 32° to 122° F
-Power Requirement:	115 Vac 50/60 Hz, ±10% 25 Va Max
-Process Var. Retr.:	Analog of the process variable is retransmitted 0 to 5 VDC into 300 ohms minimum
-Set Point Retr.:	Analog of the set point is retransmitted 0 to 5 VDC into 300 ohms minimum
-Deviation Retr.:	Analog of deviation signal ± 5 VDC for ±50% of span retransmitted into 300 ohms minimum
-Throttle Retr.:	Analog of throttle signal ± 10VDC for ± 100% throttle output into 300 ohms min.
-Machine Time Out:	Provides time delay to shut off compressors if no cooling demand is made prior to time out. Dip switch selection of 4 time out constants
-Alarm Outputs (3):	+12 VDC on, -12 VDC off, ±20 mA Max +5 VDC on, 0 VDC off, 15 mA Max LO: Indicates process variable is below setpoint more than the deviation setting HI: Indicates process variable is

above set point more than the deviation setting

HI/LO: Either HI or LO condition exists

8 selections for deviation settings

-+5 VDC Reference: Provides reference voltage for use with set point divider potentiometer

-Status LED'S: Four onboard LED's provide status of heat, cool, and automatic reset functions

-Dead Band: User adjustable

-Housing: Anodized aluminum case

-Dimensions: 12.0" long, 6.0" wide, 2.7" high

-Weight: Approximately 3 lbs.

* Other ranges available on request. Consult Sales Application Engineer.

** The 5200 standard proportioning range is zero to 50% of span. If another range of span is desired, change R22 to one of the following values. See the layout drawing for location of R22. This resistor is common to both the heat and the cool % of span, thus only one resistor needs to be changed to alter the proportion band range.

P.B. RANGE	R22=	COMPUTER NUMBER
0 to 5%	200 K	052530
0 to 25%	40.2 K	052459
0 to 50%	20.0 K	052430
0 to 100%	10.0 K	052401
0 to 200%	4.99 K	052368

4.0 TERMINAL BLOCK IDENTIFICATION

The terminal blocks are set up as follows. See the main board layout drawing for placement and numbering of the terminal blocks.

Terminal Block 1 (TB1):

01 - Negative (RED) T/C input / RTD excite
02 - Positive T/C, RTD, and analog input
03 - Negative analog and RTD input
04 - Process variable retransmit
05 - Set point retransmit
06 - Analog ground
07 - Deviation retransmit
08 - Throttle retransmit
09 - 5 VDC reference output
10 - Set point input
11 - Analog ground
12 - Machine time out (open input controlled)
13 - Cool time proportioning
14 - Output control (SSR common)
15 - Heat time proportioning
16 - External analog input (used with AUX board computer I/O)

Terminal Block 2 (TB2):

1 - Remote display select bit 1
2 - Remote display select bit 2
3 - Remote F/C select switch
4 - Digital ground
5 - Machine time out (Not open input controlled)
6 - HI/LO alarm output
7 - Digital ground
8 - HI alarm output
9 - LO alarm output

5.0 CIRCUIT DESCRIPTION:

This section briefly describes some of the important fuctions of the circuit. Refer to the block diagrams and the schematics for help in understanding the circuitry.

5.1 POWER SUPPLY

The output of transformer T1 is rectified, filtered, and supplied to U28, a 5 volt regulator. This provides power for the digital logic of the board.

The output of transformer T2 is rectified, filtered, and supplied to +15 volt and -15 volt regulators. This provides power for the analog section of the controller.

5.2 INPUT SIGNAL CONDITIONING

Thermocouple inputs are on terminals TB1-1 and TB1-2. RTD's are excited at TB1-1, and the resulting voltage is read on TB1-2 and TB1-3. Current and voltage inputs are inputted on TB1-2 and TB1-3. These input signals are all amplified and filtered by U3, a precision IC instrumentation amplifier. The gain of the input section is determined by the resistor box assembly U33. This box is easily replaced to accommodate different ranges and inputs.

Cold junction compensation for thermocouple inputs is provided by U32, a temperature transducer, which is thermally coupled to the thermocouple input. U32 has negative temperature coefficient to counteract the positive coefficient of the "cold junction".

U32 is encapsulated to shield it from any sudden ambient changes which produce unwanted thermal gradients.

Input zero is provided by R95 and is buffered by U40C.

The amplified input signal, ambient compensation signal, and the zero offset are summed and amplified with the proper weighting by U41D. Process variable span is provided by R12. The process variable is buffered by U41-A to provide the process variable retransmit, and by U41-B for the rest of the controller.

The process variable is supplied to U42B, a voltage follower. U42B output is provided with voltage limit diodes. These diodes are used here and for the setpoint, deviation, and % of output analog signals to the A/D converter to prevent latch-up on the A/D converter. The 0-5V process variable is scaled down to 0-2.5V, span by R116 and zero by R103 and fed to the A/D converter. The zero pot is buffered by U42-C so as not to load the zero signal down. Thus, the microprocessor is informed of the temperature of the process variable.

5.3 REFERENCE VOLTAGES

U32, used with thermocouple input, or VR1 for all other inputs, provides -6.8 volts which is used to derive all the reference voltages. The gain of inverter U40A is adjusted by R6 to provide a 5 volt reference. From this, U40D and pot R9 are used to provide the A/D converter with a 2.5 volt reference.

5.4 SET POINT SIGNAL

The set point signal for the controller is provided at terminals TB1-10 and TB1-11. For exciting an external set point potentiometer, +5 volt reference is provided at TB1-9. The set point signal is buffered by U43D and provided to TB1-5 for the set point retransmit signal. Jumper J1 selects either a direct or buffered set point signal to the main board. In position 1, the set point is fed directly to the control circuits. In position 2, the signal is first buffered by U43D. This option is given in case the inherent op-amp offset produces an undesirable control temperature offset. This offset can be calibrated out, or jumper position 1 can be used.

The set point signal is also transmitted by U42A to the A/D converter, again using voltage limit diodes. The 0-5V setpoint signal is also scaled down to 0-2.5V for the A/D converter. The signal is spanned by R117 and zeroed by R98. Again, the zero pot is buffered, this time by U42D to prevent pot loading errors.

5.5 ELECTRICAL ZERO AND SPAN

With any analog circuitry, there are inherent offset and span errors. These are corrected in this stage of the circuit. The process variable is fed into U41C, which inverts the process variable and conditions it up for comparison with the set point. Gain setting pot R16 and zero shift setting pot R19 are used to make the deviation signal exactly zero when the process variable and the set point are at the same potential.

5.6 DEVIATION SIGNAL

The process variable (inverted) and the set point are combined by U4, an inverting op amp with a gain of 2. This gain implies that ±2.5 volt input provides ±5 volt output representing ±50% deviation. This signal is then filtered for use by the rest of the circuit.

U43B along with voltage limit diodes conditions the deviation signal for use by the A/D converter. The deviation signal to U43B and thence to the A/D converter may be internally derived, or it may be from an external source via TB1-16. Jumper J6 selects which signal is fed to the A/D converter. In position 1, the internally derived deviation signal is passed to the digital circuit. The jumper, in position 2, connects the A/D converter to TB1-16. Now, an analog signal from an external

source is monitored by the microprocessor, and in conjunction with the serial or GPIB options, can be passed on to a host computer.

5.7 AUTOMATIC RESET

The deviation signal is presented to U10, configured as a long term integrator. The integrating time constant is determined by the capacitor C4 and the total value of the resistors selected by S2, a rotary switch. K1 and K2 relay contacts provide a two stage anti-windup function. Each relay, K1 and K2, has a yellow LED (XR3 and XR4) to monitor the status of the automatic reset and anti-windup function.

U16, a Z80 microprocessor IC, determines when the output is theoretically within a ± 110% throttle range and energizes both K1 (hold) and K2 (reset) relays the integrator, or automatic reset circuit is fully functional. When the throttle exceeds the ± 110% throttle range, K1 relay releases which places the integrator into a hold condition. The value of automatic reset voltage stored on capacitor C4 is held unchanging. Internal to the microprocessor, a timer is started when the integrator is placed in hold. If the hold condition exists for 45 seconds without the throttle coming back down to ± 100% throttle, the reset relay, K2 is de-energized. This causes C4 to discharge and eliminate any reset signal built up by the integrator. This is necessary to prevent large oscillations from occurring to the control after a step change on the set point. If, while in hold (step 1), the throttle does come down to ± 100% throttle, then both K1 and K2 are again energized, the 45 second counter is reset, and the automatic reset will continue integrating the throttle signal from the value that existed during the hold.

Note the 110/100% values used. This introduces a small hysteresis into the anti-windup, so rapid oscillation between step 1 and step 2 of the 2 stage system does not occur.

5.8 MANUAL OUTPUT

During normal controller operation, jumper J7 is in position 1. This passes the integrated deviation signal to circuitry which derives the proportional heat/cool signals. For testing purposes, a manual output may be used. With jumper J7 in position 2, R49 is adjusted for the desired throttle and the signal buffered by U38. To get best resolution from the manual output, turn heat and cool proportional gain pots fully C.W. (R53 & R54).

5.9 PROPORTIONAL GAIN

The deviation signal selected by J7 is fed into U38C for use by the cool proportioning circuitry. The signal is inverted by U38A and fed to U38D for the heat proportional band. The heat proportional band is adjusted by changing the gain of U38-D with pot R53. The cool proportional band is adjusted with R54 by changing the gain of U38-C. The output of each proportional band amp (U38-C and U38-D) provides a 0 to -5 volt signal representing a 0 to 100% cool or heat throttle.

5.10 DEAD BAND

Dead band is provided by adjusting R57. This pot selects a small bias to be applied to the proportional band gain op amps.

5.11 TIME PROPORTIONING

This controller provides independent heat and cool signal control circuitry. This permits independent adjustment of the signals for best control. The circuitry for the cool signal is almost identical to that for the heat signal as can be seen on schematic drawing 471096. For that reason, only the heat circuitry is described.

A triangle waveform is generated by U39A and U39B. The triangle wave will be combined with the deviation correction voltage to provide a variable ON/OFF cycle for solid state control relays. If the deviation from set point was at a value calling for 50% output throttle, the ON time and the OFF time would be of equal duration per cycle.

U39A is a voltage comparator whose output is saturated at either ±14 volts depending upon its inputs. The square wave output of U39A is integrated by C3 and R29, and in conjunction with U39B provides a triangle wave of the opposite polarity of the output of U39A. Since they are 180 degrees out of phase, feed back of triangle wave output to the input of U39A through R26, R27 and R31, causes the square wave polarity to switch. R31 is adjustable, so the amplitude of the triangle wave can be adjusted.

A capacitor will charge to any potential at a rate determined by the RC time (exponential) no matter how great or small the potential. Therefore, if the whole ±14 volt square wave is integrated, C3 will charge to a potential where the magnitude of the sawtooth wave causes a switch in the output of U39A in a short period of time. If less than the full ±14 volts is integrated, C3 takes longer to reach the value causing U39A output to toggle. Thus, the setting of R28 determines the cycle rate of the triangle wave generator by selecting the value to be integrated.

The ±2.5 volt sawtooth and an effective 2.5 volt offset, added here, are summed and inverted by U37D to provide a 0 to -5 volt sawtooth wave. This 0 to -5 volt signal is fed into comparator U37B (+) input. The (-) input of U37B receives the 0 to -5 volt signal (for 0 to 100% throttle). When these inputs are combined, the output of the U37B saturates positive when heat is needed, and negative when heat is not needed. After this time proportioned heat signal is filtered, U37C buffers the signal, and then feeds it through red heat LED XR1 to TB1-15. As explained, the cool circuitry functions the same way as the heat circuitry. The cool time proportioned signal passes through green LED XR2 to TB1-13.

5.12 ANALOG THROTTLE

The heat and cool signals provided by the proportional band stages (U38-D and U38-C) are not only used by the time proportioning stage mentioned above, but are also used by the output throttle stage. Again, the heat and cool stages are analogous, so only the heat will be described. Only part designations change for the cool stage. The 0 to -5 volt signal from U38D representing a 0 to 100% heat requirement actually contains a cool signal The cool portion of U38D output is removed by U37A, configured as an ideal diode. The remaining heat signal then goes into U36D, a voltage follower. The cool stage has a voltage inverter instead of a follower. This puts the heat and cool signals back into their proper quadrants. The heat and the cool signals are re-combined by U36C, an inverting summer, with a gain of two. This op amp produces -10 volts to +10 volts representing -100% (cool) to +100% (heat) throttles. The signal is also re-combined by U36-A, and voltage limited for use by the digital A/D converter.

5.13 DIGITAL CIRCUITS

The digital circuit provides open loop monitoring type functions. With this concept, the system can be easily upgraded to interface to a computer, while also simplifying the monitoring functions on the main board (like machine time out, anti-windup circuitry and deviation alarms).

The heart of the digital circuit is U16, a Z-80 microprocessor which controls all the peripheral digital circuitry. U31 is a clock oscillator. It provides for all the digital timing functions of the controller as well as providing a buffered output to connector P2 for use on the auxiliary board.

U31 output is provided to U12 and U13, frequency dividers which produce sub-multiples of the main frequency. U12 produces different baud rates for use on the serial auxiliary board, and U13 divides down to a 50 milli-second pulse for timing interrupts in the Z-80. This 50 milli-second pulse is fed into the non-maskable interrupt of the Z-80 for internal timing purposes. It is also fed into U27, where the rising edge will strobe a maskable interrupt into the Z-80. When the maskable interrupt is processed by the Z-80, the interrupt acknowlege line is activated, clearing the interrupt line to the Z-80. This must be done on the maskable interrupt, because it is level sensitive, whereas the non-maskable interrupt is edge triggered. Transistor Q4 and its associated resistors reduce the cool T/P pulse from ±12 volts to TTL levels. This data is used by the Z-80 CPU to determine machine time out.

U11 is a four channel A/D converter which monitors the temperature, setpoint, % output throttle, and the deviation. As previously noted, the deviation may be internally derived or provided from a remote source via the GPIB or serial (RS232) auxiliary I/O option board as selected by J6. Also previously noted were the temperature and set point signals being provided with zero and span pots, buffers, and voltage limiting diodes. The span of the controller is presented to U11 as 0 - 2.5 volts instead of the 0 - 5 volt span of the rest of the controller.

U23, U24, and U25 provide the Z-80 with EPROM and RAM. These are configured with jumpers J3, J4, and J5 for different types of memory. Position 1 is for 2716 style EPROMS, position 2 is for 2732 and 2764 EPROMS, and position 3 is for RAMS.

U19 is an output latch to hold data for the anti-windup hold and reset control, the master output control, and the machine time out control. Q1, Q2, Q3, Q5 and Q6 provide current gain for their functions. CR5 and CR6 provide protection against the coil collapse of K1 and K2. XR3 and XR4 indicate the status of the relay, and thus of the anti-windup circuitry. CR1 is used to insure that Q3 will be used only to sink current.

U20 is also an output latch for holding the alarm status, another machine timeout status, and also for data and clock lines to the optional LCD display board. U21 provides a current boost for the TTL signals from U20.

U22 is an input buffer for the contents of the status switch SW1 which is used to select the various options. U34 is a sip resistor package for pullup resistors on the switch lines.

U17 and U18 are 4 to 10 line multiplexers, and they are used to memory map all the peripheral chips used.

6.0 MEMORY MAP

Memory Locations	Device Selected
0000H-1FFFH	memory 1 (U23)
2000H-3FFFH	memory 2 (U24)
4000H-5FFFH	memory 3 (U25)
6000H-DFFFH	empty
E000H-E3FFH	A/D chip (U11)
E400H-E7FFH	option switch input
E800H-EBFFH	display/mto/alarm outputs
EC00H-EFFFH	control outputs
F000H-F3FFH	CS0 option (GPIB/RS232 chip)
F400H-F7FFH	CS1 option (address switch read)
F800H-FBFFH	CS2 option (set point lo byte)
FC00H-FFFFH	CS3 option (set point hi byte)

7.0 JUMPER AND SWITCH OPTION SUMMARY

Jumper/Position	Function Selected
J1/1	Set point input not buffered
J1/2	Set point input buffered
J2/1	Maskable interrupt on MTO
J2/2	Maskable interrupt on I/O interrupt
J3/1	2716 EPROM in U23
J3/2	2732 or 2764 EPROM in U23
J3/3	RAM device in U23
J4/1	2716 EPROM in U24
J4/2	2732 or 2764 EPROM in U24
J4/3	RAM device in U24
J5/1	2716 EPROM in U25
J5/2	2732 or 2764 EPROM in U25
J5/3	RAM device in U25
J6/1	A/D channel 4 reads deviation
J6/2	A/D channel 4 reads external input
J7/1	Automatic output throttle
J7/2	Manual output throttle (Adjust with R49)

Switch Positions	Switch Selection	Options Selected
1 and 2	21 00 01 10 11	display reads: temperature set point output deviation
3	3 0 1	units of degrees: F C
4, 5 and 6	654 000 001 010 011 100 101 110 111	alarm dev. band: 1 degree F. 2 degrees F. 5 degrees F. 10 degrees F. 25 degrees F. 50 degrees F. 100 degrees F. infinity
7 and 8	87 00 01 10 11	mach. time out, sec.: STD. Option 5(SPD) 30 90 60 120 120 240 240 360

The dip switch positions are numbered on one side. The numbered side depressed equals "0", the unnumbered side equals "1". An example of the above table usage - for an alarm deviation band of 10°, depress unnumbered side of positions 6 and 5, and the numbered side of position 4.

Note: When the digital display option is provided, switch positions 1, 2, and 3 should all be set to (1).

8.0 ALIGNMENT AND CALIBRATION PROCEDURE

Equipment Needed:
-Digital volt meter with .001 volt resolution
-Thermocouple calibrator pot, 1 degree F res.
or precision voltage source, resolution .001 volts
or precision current source, resolution .01 mA
-One test clip lead
-Five 2.0 K ohm resistors, 1/8 watt or greater, 1% tolerance
-A timer or watch, resolution of 1 second
-Oscilloscope 50 MV/div A/C range, 2V/div D/C range
-115 volt power cord and variable supply

> CAUTION
>
> Hazardous potentials exist on the circuit board when power is applied. Use extreme caution when calibrating.

Notes:

Tests performed with the oscilloscope and the variable supply may be omitted if the unit is being realigned after initial calibration. If the unit has been performing correctly, only the DVM and T/C pot are required to perform steps 8.2, 8.3 and 8.6. The rest of the tests are merely performance checks.

Refer to drawing 471166 for pots, jumpers, and test point locations when calibrating.

All references to input signal refer to a type "T" thermocouple input. If other input is used, such as current or voltage, reference it rather than the thermocouple potentiometer.

Install the jumpers as follows: J1/1, J2/1, J3/2, J4/2, J5/3, J6/1, J7/1

8.1 POWER SUPPLY CHECK

1. Connect the scope and DVM ground leads to TP19
2. Connect the power line, neutral, and earth wires to the controller, and plug in to variable power source.
3. Apply 115 volts AC to the unit.
4. Connect DVM (+) lead to TP18; should be(S.B.) +15VDC ±0.6VDC
5. Connect scope (+) lead to TP18; S.B. less than 30mV AC noise
6. Vary the AC power supply from 100 to 130 VAC and be sure that the parameters used in steps 4 and 5 still hold true.
7. Connect DVM (+) lead to TP20; S.B. -15VDC ±0.6VDC
8. Connect scope (+) lead to TP20; S.B. less than 30mV AC noise
9. Vary the AC power supply from 100 to 130 VAC and be sure

that the parameters used in steps 7 and 8 still hold true

10. Connect DVM (+) lead to TP17; S.B. +5 VDC ±0.2 VDC
11. Connect scope (+) lead to TP17; S.B. less than 30 mV AC noise
12. Vary the AC power supply from 100 to 130 VAC and be sure that the parameters used in steps 10 and 11 still hold true.

8.2 REFERENCE VOLTAGE ADJUSTMENTS

13. Install the thermocouple calibrator pot to proper inputs. Red wire (-) to TB1-1 and the blue wire (+) to TB1-2.
14. Connect the (+) DVM lead to TP8 and adjust R6 so DVM reads +5.000 VDC ± .001 VDC.
15. Connect the (+) DVM lead to TP9 and verify that it reads -5.0 VDC ±.03 VDC.
16. Connect the (+) DVM lead to TP7 and adjust R9 so DVM reads +2.500 VDC ±.001 VDC

8.3 FRONT END CALIBRATION

17. Set the thermocouple pot (installed in step 13) to 25% of full scale. (29 degrees F for standard range).
18. Connect the DVM (+) lead to TP3 and set R95 so DVM reads +1.250 VDC ±.001 VDC
19. Connect the DVM (+) lead to TP4 and adjust R103 so DVM reads +0.625 VDC ± .001 VDC.
20. Set the thermocouple pot to 75% of full scale. (+271 degrees F for standard range).
21. Connect the DVM (+) lead to TP3 and set R12 so DVM reads +3.750 VDC ±.001 VDC.
22. Connect the DVM (+) lead to TP4 and adjust R116 so DVM reads +1.875 ±.001 VDC.
23. Repeat steps 17 thru 22 until all values fall in the ±.001 VDC range without any further resistor adjustments.

8.4 SET POINT CALIBRATION

24. Verify jumper J1 in position 1.
25. Connect the jumper wire from TP3 to TB1-10.
26. Monitor the voltage of TB1-10 with the (+) lead of DVM and set the thermocouple pot so DVM reads +1.250 VDC ±.001 VDC. (29 degree F standard range)
27. Monitor TP5 with the (+) lead of the DVM and adjust R98 so the DVM reads +0.625 ±.001 VDC.
28. Monitor the voltage of TB1-10 with the (+) lead of the DVM and set the thermocouple pot so DVM reads +3.75 VDC ±.001 VDC. (271 degree F standard range)
29. Monitor TP5 with the (+) lead of the DVM and adjust R117 so the DVM reads +1.875 ±.001 VDC.
30. Repeat steps 26 thru 29 until values are within tolerance without further adjustment of the resistors.

8.5 A/D VOLTAGE LIMIT CHECK

31. Monitor TP4 with the DVM and swing the thermocouple pot below and above the specified range of the controller. Be sure that the voltage displayed by the DVM does not go more negative than -0.2 volts, or more positive than 5.0 volts
32. Monitor TP5 with the DVM, and repeat the procedure in step 31.

8.6 ELECTRICAL ZERO AND SPAN

33. Place the rotary switch SW2 in position 10 (reset off).
34. Place the (+) lead of DVM on TP12.
35. Set the thermocouple pot at approximately 25% of full scale (value not critical) and adjust R19 so the DVM reads 0.00 volts ±0.01 VDC.
36. Set the thermocouple pot at approximately 75% of full scale (value not critical) and adjust R16 so DVM reads 0.00 volts ±0.01 VDC.
37. Repeat steps 35 and 36 until values are within tolerance without further adjustment of the resistors.

8.7 CYCLE AMPLITUDE ADJUST

38. Install a 2 K ohm resistor between TB1-13 and TB1-14.
39. Install a 2 K ohm resistor between TB1-14 and TB1-15.
40. Remove the jumper clip found on jumper J7.
41. Remove the jumper wire from TP3 to TB1-10 and install it between TB1-11 and the center post of J7.
42. Turn R53 and R54 (proportion bands) fully C.W., pots R28 and R71 (cycle rates) fully C.C.W., and R57 (dead band) fully C.C.W.
43. Connect the scope (+) lead to U37 pin 7.
44. Set pot R28 fully C.W.
45. Monitor the scope for ±12 VDC pulses and/or the red L.E.D. XR1 for ON/OFF pulses, and adjust R31 so the pulses just disappear.
46. Connect the scope (+) lead to U35 pin 7.
47. Set pot R71 fully C.C.W.
48. Monitor the scope for ±12 VDC pulses and/or the green L.E.D. XR2 for ON/OFF pulses, and adjust R74 so the pulses just disappear.

8.8 MANUAL OUTPUT CHECK

49. Remove wire between TB1-11 and centerpost of J7. Place the jumper clip on this jumper to position 2 (manual output).
50. Adjust the manual output pot R49 fully C.C.W. and look for full cool, the green L.E.D. on all the time. Now, slowly rotate R49 C.W. and monitor the red and green L.E.D.'s. The green one should start to pulse, then go off when the pot is at mid-range, then the red L.E.D. should begin to pulse, going to full ON when the pot is fully C.W.

8.9 CYCLE, PROPORTIONAL BAND AND DEAD BAND CHECK

51. Set R49 (manual output) so the green Cool L.E.D. is on about 50% of the time.
52. Rotate R71 (cycle cool) slowly C.W. and check that the pulses to the green L.E.D. go slower and slower. Return pot to full C.C.W. position.
53. Rotate R54 (cool proportional band) slowly C.C.W. and check that the green L.E.D. duty cycle gets longer, until it stays on all the time. Return to full C.W. position.
54. Rotate R57 (dead band) slowly C.W. and check that the green L.E.D. duty cycle gets shorter. Return to full C.C.W. position.
55. Set R49 (manual output) so the red Heat L.E.D. is on about 50% of the time.
56. Rotate R28 (cycle heat) slowly C.W. and check that the pulses to the red L.E.D. go slower and slower. Return pot to full C.C.W. position.
57. Rotate R53 (heat proportional band) slowly C.C.W. and check that the red L.E.D. duty cycle gets longer, until it stays on all the time. Return to full C.W. position.
58. Rotate R57 (dead band) slowly C.W. and check that the red L.E.D. duty cycle gets shorter. Return it to full C.C.W. position.

8.10 THROTTLE OUTPUT CHECK

59. Monitor TB1-8 with the DVM.
60. Set R49 (manual output) for 100% cool cycle (green L.E.D. pulsing just ceases).
61. Check DVM for a reading of -10.0 ±0.5 VDC.
62. Set R49 (manual output for 100% heat cycle (red L.E.D. pulsing just ceases).
63. Check DVM for a reading of +10.0 ±0.5 VDC.

8.11 A/D VOLTAGE LIMIT CHECK

64. Verify jumper J6 in position 1 and J7 in position 2.
65. Insert a 2.0 K ohm resistor between TB1-9 and TB1-10. Insert another one between TB1-10 and TB1-11.
66. Monitor TP10 with the DVM, and vary the thermocouple pot above and below the rated input range. Watch the DVM and verify that the voltage varies up and down in scale, but never below -0.2 VDC or above 5.0 VDC.
67. Monitor TP11 with the DVM. Vary R49 (manual output) to both extremes of the pot, and verify that the DVM reading changes, but does not go more negative than -0.2 or more positive than +5.0 VDC.
68. Change J7 jumper from position 2 (Manual) to position 1 (Auto).

8.12 INTEGRATOR CHECK

69. Monitor TP12 with the DVM, and adjust the thermocouple pot so the DVM reads +2.5 ±.05 VDC. Both yellow L.E.D.'s should be on (XR3 and XR4).

70. Rotate the integrator time constant switch (SW2) from position 10 to position 1. Simultaneously, start a timer. The time for the voltage to ramp from 2.50 VDC to 5.00 VDC should be between 18 and 20 seconds.
71. Rotate the integrator switch (SW2) to position 10. The DVM should read 2.50 VDC. Now, rotate the switch (SW2) to position 8. Simultaneously, start a timer. The time for the voltage to ramp from 2.50 VDC to 2.60 VDC should be between 18 and 20 seconds.
72. Return the integrator switch (SW2) to position 10.

8.13 ANTI-WINDUP CHECK

73. Set the thermocouple pot at the bottom of the 5200 input range (-125 F standard). After a brief moment, a yellow L.E.D. (XR3) will turn off. Start a timer running. The time elapsed before L.E.D. (XR4) turns off should be between 40 and 50 seconds.
74. With DVM (+) lead on TP12, adjust thermocouple pot until the deviation voltage reading on DVM is between ± 1.0 VDC. Both yellow L.E.D.'s (XR3 and XR4) should come on simultaneously after a brief moment.

8.14 OPEN T/C CHECK

75. Set the thermocouple pot at bottom of input range. The green L.E.D. should be lit. Disconnect the thermocouple pot from the input. After a brief wait, the L.E.D. should turn off. Now re-connect the T/C pot. The green L.E.D. should turn on after a brief moment.

8.15 MACHINE TIME OUT CHECK

76. Place a 2.0 K ohm resistor between TB1-12 and TB1-14. Monitor the voltage at TB1-12 with the DVM. Set the dip switch (SW1) positions 7 and 8 both to (0). Turn the thermocouple pot to a high temperature such that the green L.E.D. is full ON. Now, turn the thermocouple pot to a low temperature so the green L.E.D. turns off completely. Simultaneously, start the timer. The voltage on the DVM should read approximately 12 VDC. After 25 to 35 seconds, or with option 5 provided 85 to 95 seconds, the DVM reading should drop to less than 1 VDC. Now, move the DVM to TB2-5. This voltage should also be less than 1 VDC. Turn the thermocouple temperature to a high temperature lighting the green L.E.D. the voltage on the DVM should read above 3.0 VDC.

8.16 ALARM BAND CHECK

77. Set the dip switch (SW1) position 6 to (1) and positions 4 and 5 to (0). Monitor TB2-6 with the DVM. Turn the thermocouple pot to the bottom of the rated 5200 range. The DVM should read above 3.0 VDC. Turn the thermocouple pot up until the green and red L.E.D. are off, or have very short pulses. After a brief moment, the DVM should

indicate a voltage below 1.0 VDC. Now, increase the thermocouple pot to the top of the 5200 range. After a brief moment, the DVM should again indicate a voltage above 3.0 VDC.

78. With the thermocouple pot still at the high end, check TB2-9 (hi alarm) with the DVM. It should be above 3.0 VDC. Check also TB2-8 (lo alarm) for a voltage less than 1.0 VDC.

79. Turn the thermocouple pot to the bottom of the 5200 range. Check TB2-8 (lo alarm) for a voltage level above 3.0 VDC. It will take a few seconds for the logic level to switch states. Now, check TB2-9 (hi alarm) for a voltage less than 1.0 VDC.

8.17 FINAL PREPARATIONS

80. Remove the resistors which were installed on the terminal blocks. Remove the thermocouple calibrator pot, the DVM and the scope if still installed. Remove also the 120 VAC power source. Install or verify jumpers J1/1, J2/1, J3/2, J4/2, J5/3, J6/1, J7/1. The switch (SW1) should be set up as 00100100 from position 1 to position 8.

81. The unit is now calibrated, and should stay within given specifications for at least 6 months. If unit is subjected to severe vibrations or shock, it may require calibration sooner.

9.0 CONTROLLER 012003 REPLACEMENT AND DIGITAL SET POT or 013005 T.I./S.P. ASSEMBLY S.P. SOURCE

There are occasions, such as replacing another type controller with a 5200 controller, where additional procedures are required. Examples are given of replacing a Thermotron 012003 controller with a 5200 controller, and also of changes necessary to function with a digital set pot using a % of Span table, or set point source such as the Thermotron 013005 Temperature Indicator/Set Point Assembly.

To convert from 012003 controller to a 5200 controller, remove connection wires from the 003 and add them to the equivalent 5200 terminals. Terminals not used on the 003 are also unused on the 5200

003	SIGNAL NAME	5200	
TB1-1	LINE	L	
TB1-2	NEUTRAL	N	
TB1-3	EARTH	E	
TB2-1	T/C +	TB1-2	
TB2-2	T/C -	TB1-1	
TB2-3	NO CONNECTION	-	
TB3-1	MTO SIGNAL	TB1-12	
TB3-2	COOL SIGNAL	TB1-13	
TB3-3	HEAT SIGNAL	TB1-15	
TB3-4	DEV METER +	TB1-7	- In series with 10K re-
TB3-5	DEV METER -	TB1-6	sistor if driving analo
TB3-6	GND(SSR COM.)	TB1-14	meter
TB3-7	GND	TB1-11	
TB3-8	SET POINT IN	TB1-10	
TB3-9	P.V. INPUT	-	
TB3-10	P.V. OUTPUT	TB1-4	
TB3-11	S.P. POT EXCITE	TB1-9	

If a set point source such as the Thremotron T.I./S.P. Assembly 013005, or a digital % of Span pot are used with the 5200, remove R101 from the circuit. This resistor is located next to jumper J6 (see drawing 471166). Also place jumper J1 in position 2 to buffer the set point. A slight calibration change is necessary when operating with the 013005 T.I./S.P. assembly. The set point excitation voltage must be raised slightly. With the 013005 connected and the zero and span adjustments made (see User's Manual for that circuit), set the high set point index for the upper controller range (+375°F standard). With the DVM (-) lead on TB1-11 and the (+) lead on TB1-10, adjust controller R6 until DVM reads 5.000± .001 V.D.C.

This procedure changes the reference voltages of section 8.2. Therefore, it is necessary to check the calibrations covered in sections 8.3, 8.4, and 8.6 and adjust as necessary. Note that jumper J1 remains in position 2, not in position 1 as specified in step 24.

10.0 OPERATOR PARAMETER TUNING

Tuning adjusts the controller to the controlled apparatus. The following sequence gives initial adjustments to permit control of minor process changes and good recovery from major changes in set point.

Allow sufficient time for stabilization of the controlled apparatus after each change in set point before introducing the next change.

10.1 PROPORTIONING BAND ADJUSTMENT

The heat and cool proportioning circuitry is identical except for component designation. The cool circuitry in this description is in ( ).

The proportional band is adjusted by R53 (R54). R53 (R54) varies the gain of U38D (U38C) and thereby controls the width of the proportional band. The greater the gain [R53(R54)C.C.W.] , the narrower the band and vice versa.

Set R53 (R54) full c.w. for widest proportional band. Place switch SW2 in position 10 to disable the integrator reset circuitry. Set cycle rate adjustments R28 (R71) approximately mid-range. As the tuning proceeds, the cycle times may be adjusted for the best visual indication of the heat or cool outputs (C.C.W.-Faster, C.W.-Slower). A faster cycle rate normally gives better control for heating; a slightly slower rate works better for cooling. This is a common-sense adjustment in that the slowest rate that gives good control lengthens the life of the control apparatus.

Select a set point and allow the process to stabilize. Change the set point up or down and adjust the gain controls, R53 or R54 depending on whether heat or cooling is being added to the process, in a clockwise direction to narrow the proportional band. In response to changes, up or down in the setpoint, keep increasing the gain until system begins to oscillate around the set point. Then adjust R53 (R54) C.C.W. until oscillations cease. The system will now stabilize at some point close to, but not exactly at set point (droop).

10.2 RESET CONTROL

The condition known as droop occurs because of thermal losses within the system. To overcome droop, it is necessary to change the set point or to add enough to the input signal to return the system to set point. The method of automatic reset chosen for this controller involves integrating a portion of the heat or cool deviation signal and in effect adding this integrated voltage to the deviation input.

Add reset action by placing switch SW2 in position 8 (slowest reset) and observe control action in response to changes in setpoint, either up or down. Reset control affects both heat and cool signals. Increase the rate of reset (SW2 in lower numbered direction) until damped oscillations are slightly larger than acceptable. Now decrease the proportional gain by adjusting R53 (R54) C.W. slightly until controlled apparatus quickly and smoothly responds to changes in setpoint. Remember that reset affects both heat and cool, so check both.

Optimum controller adjustments need not be the finest and most sensitive adjustments, but rather those that produce satisfactory results in a stable system.

10.3 MACHINE TIME OUT

The machine or compressor time out period is determined by positions 7 and 8 of the dip switch (see section 7). This is another common-sense adjustment to avoid shortening the compressor life by on and off cycling.

Adjust the setpoint so that refrigeration is required. If the cooling valves are being pulsed periodically, the dip switch setting can be changed so that the compressors remain running between pulses, but does not run an excessive period when cooling is not required.

10.4 IN CASE OF DIFFICULTY

This controller operates on the closed loop principle. This means that a feedback signal from some type of sensor is used to indicate the process level. This feedback signal is compared to the setpoint signal to generate control action.

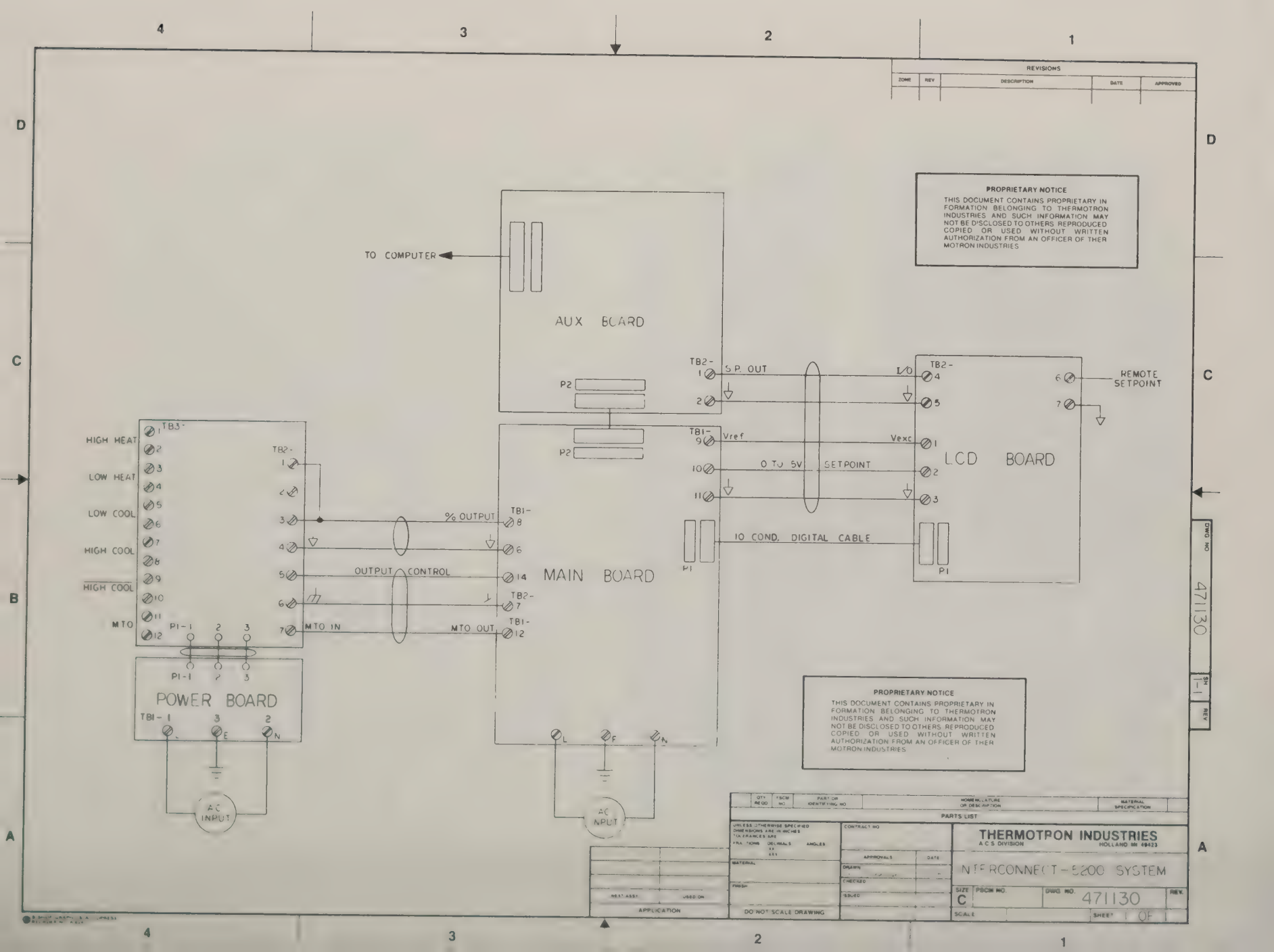
If reasonable performance is difficult to achieve, the reason may be due to late feedback information to the controller. A few seconds delay can seriously degrade control performance. This means that the response of the sensor has to be fast, and the sensor has to be well located in the air stream. A sheathed sensor won't work because it is not fast enough. Likewise, a poorly constructed bare thermocouple will also cause problems. At least four (4) inches of insulation should be stripped away from the junction of the thermocouple, and this entire sensitive length should be well exposed to the air stream. Any clamps or fittings should be at least six (6) inches away from the junction, and preferably loose fitting - not clamped down tightly on the wire. If the sensor is located in a 'dead spot', or shaded by another sensor, this can also appear as poor sensor response.

In test systems, this is usually the problem. Lags associated with the air flow rate do not usually cause problems, except in ducted air supplies which operate at very low exhaust velocity.

If a temperature recorder is being used to monitor control performance, be sure that the recorder is telling the truth prior to readjusting the controller. What looks like 'undershoot', slow response to small load variations, or a slow temperature drift, might well be attributable to the recorder and its sensor. The response of the controller, when properly applied and adjusted, is likely to be equal or better than that of an associated temperature recorder. This is especially true if the recorder is equipped with a platinum resistance temperature sensor - which many prefer in the interest of theoretical accuracy.

One other possible difficulty may be drift due to thermocouple deterioration. This problem, if suspected, may be checked by placing a test thermocouple as close to the suspected thermocouple as possible. If the output of the thermocouple under test differs from what is acceptable by the user, then the thermocouple should be replaced.

An alternative to this is to replace a thermocouple if it is suspect.


REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
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TO COMPUTER
AUX BOARD
P2
TB2-
1
2
S.P. OUT
I/O
TB2-
4
5
6
7
REMOTE SETPOINT
TB1-
9
10
11
Vref
0 TO 5V
SETPOINT
Vexc
1
2
3
LCD BOARD
P1
10 COND. DIGITAL CABLE
MAIN BOARD
TB3-
HIGH HEAT
LOW HEAT
LOW COOL
HIGH COOL
HIGH COOL
MTO
1
2
3
4
5
6
7
8
9
10
11
12
TB2-
1
3
4
5
6
7
% OUTPUT
OUTPUT CONTROL
MTO IN
TB1-
8
6
14
TB2-
7
MTO OUT
TB1-
12
P1-1
2
3
POWER BOARD
TB1-1
3
2
E
N
AC INPUT
L
F
N
AC INPUT
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QTY REQD
PSCM NO.
PART OR IDENTIFYING NO.
NOMENCLATURE OR DESCRIPTION
MATERIAL SPECIFICATION
PARTS LIST
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THERMOTRON INDUSTRIES
A C S DIVISION
HOLLAND MI 49423
INTERCONNECT - 5200 SYSTEM
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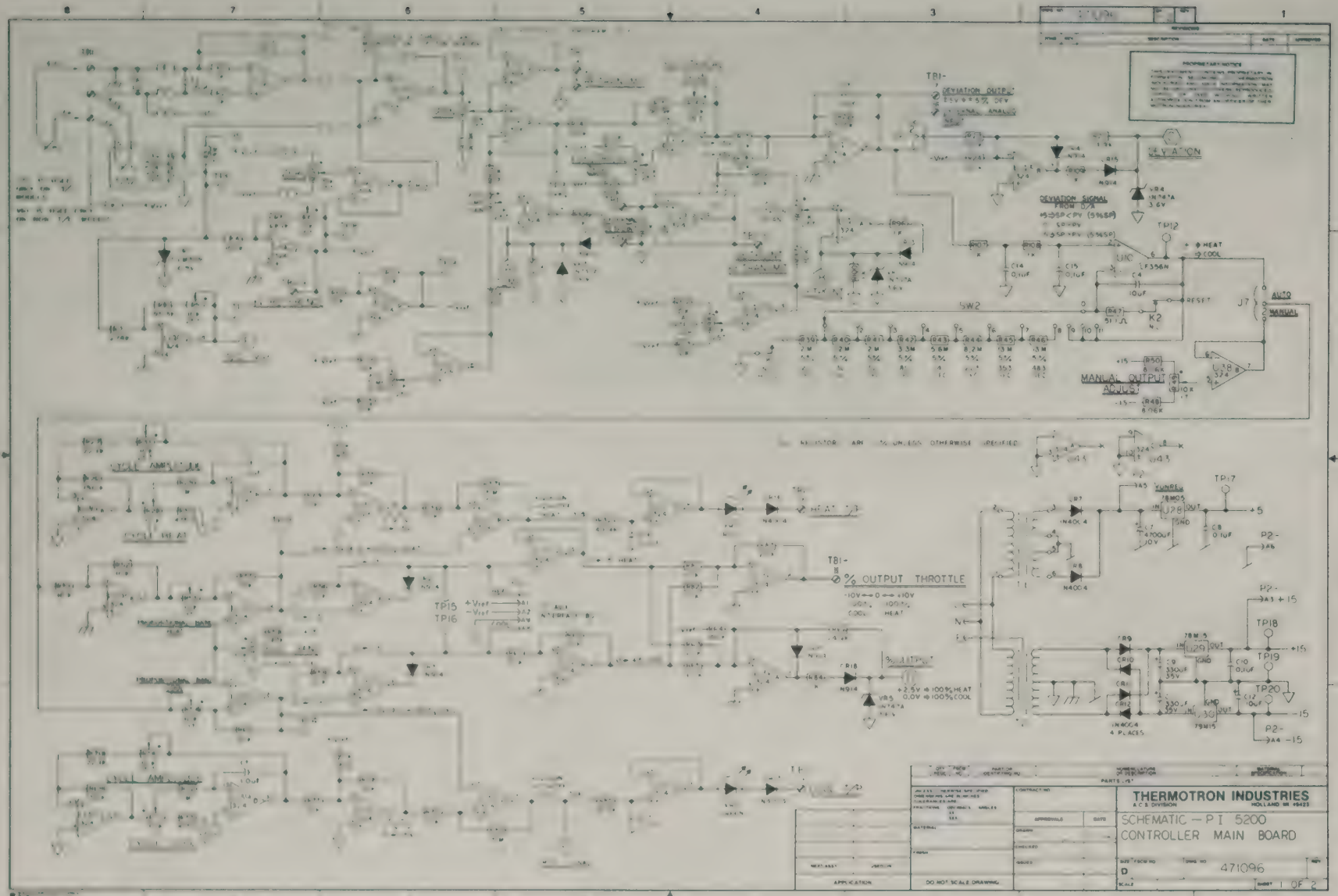
DWG NO. 471130
REV.
SCALE
SHEET 1 OF 1
DWG NO 471130
REV 1-1


TB1-
DEVIATION OUTPUT
0 TO +5V @ 5% DEV
SIGNAL ANALOG
DEVIATION SIGNAL FROM D/A
+5=SP<PV (5%SP)
0=PV=SP (5%SP)
TP12
+ = HEAT
- = COOL
U1C
LF356N
C4
.01UF
RESET
SW2
K2
AUTO
MANUAL
J7
MANUAL OUTPUT ADJUST
TB1-
% OUTPUT THROTTLE
-10V ⟷ 0 ⟷ +10V
100% COOL
100% HEAT
TP15
TP16
+Vref
-Vref
TP17
TP18
TP19
TP20
+5
+15
-15
P2-A3 +15
P2-A4 -15
P2-A6
4 PLACES
THERMOTRON INDUSTRIES
A C S DIVISION
HOLLAND MI 49423
SCHEMATIC — P I 5200
CONTROLLER MAIN BOARD
471096
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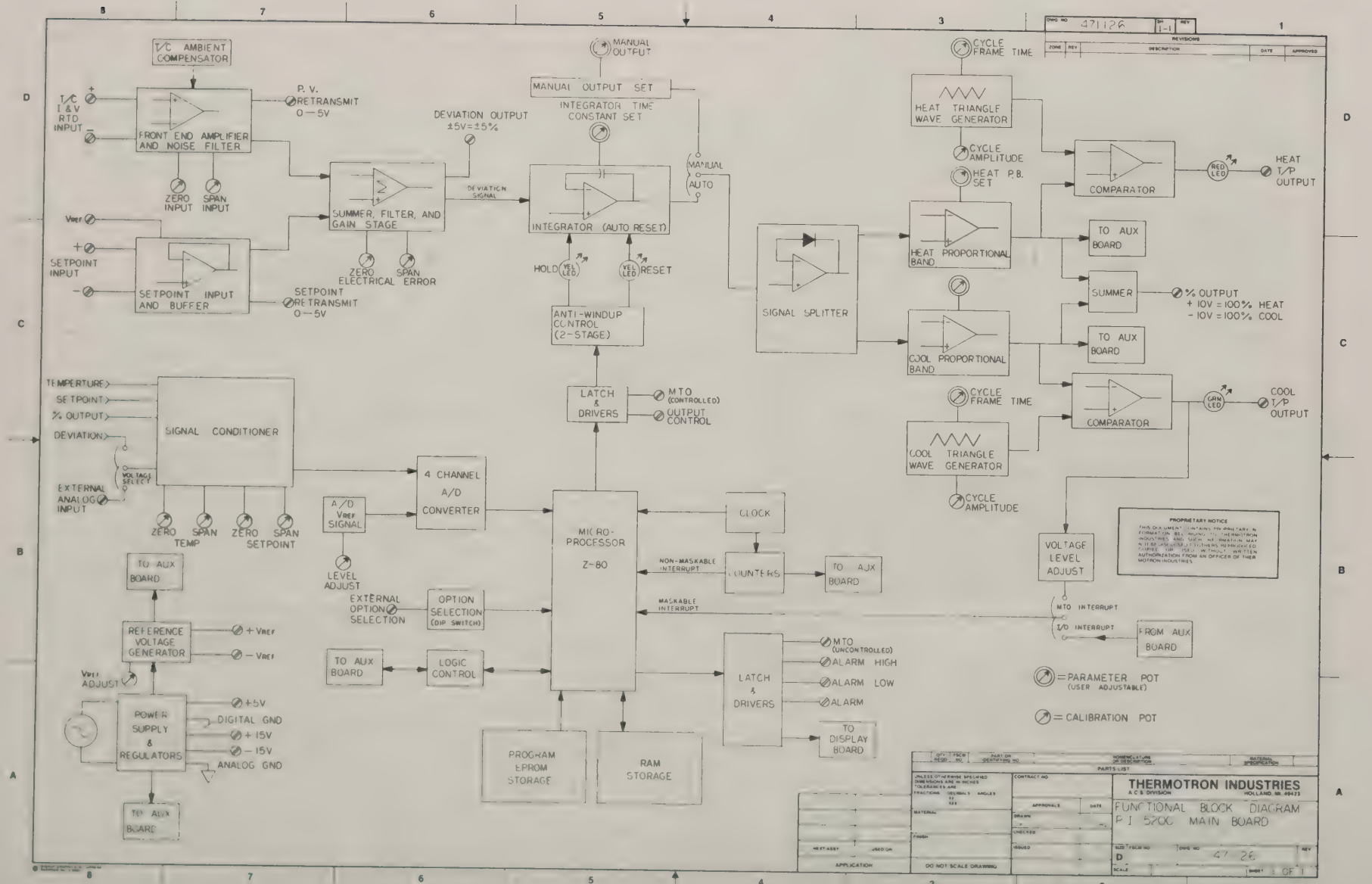
DO NOT SCALE DRAWING


T/C AMBIENT COMPENSATOR
T/C I & V RTD INPUT
FRONT END AMPLIFIER AND NOISE FILTER
P. V. RETRANSMIT 0—5V
ZERO INPUT
SPAN INPUT
VREF
SETPOINT INPUT
SETPOINT INPUT AND BUFFER
SETPOINT RETRANSMIT 0—5V
SUMMER, FILTER, AND GAIN STAGE
ZERO ELECTRICAL
SPAN ERROR
DEVIATION OUTPUT ±5V=±5%
DEVIATION SIGNAL
MANUAL OUTPUT
MANUAL OUTPUT SET
INTEGRATOR TIME CONSTANT SET
INTEGRATOR (AUTO RESET)
MANUAL
AUTO
HOLD
YEL LED
RESET
ANTI-WINDUP CONTROL (2-STAGE)
SIGNAL SPLITTER
CYCLE FRAME TIME
HEAT TRIANGLE WAVE GENERATOR
CYCLE AMPLITUDE
HEAT P.B. SET
COMPARATOR
RED LED
HEAT T/P OUTPUT
HEAT PROPORTIONAL BAND
TO AUX BOARD
SUMMER
% OUTPUT + 10V = 100% HEAT - 10V = 100% COOL
COOL PROPORTIONAL BAND
TO AUX BOARD
CYCLE FRAME TIME
COOL TRIANGLE WAVE GENERATOR
CYCLE AMPLITUDE
COMPARATOR
GRN LED
COOL T/P OUTPUT
LATCH & DRIVERS
M.T.O (CONTROLLED)
OUTPUT CONTROL
TEMPERTURE
SETPOINT
% OUTPUT
DEVIATION
VOLTAGE SELECT
EXTERNAL ANALOG INPUT
SIGNAL CONDITIONER
ZERO TEMP
SPAN TEMP
ZERO SETPOINT
SPAN SETPOINT
A/D VREF SIGNAL
LEVEL ADJUST
4 CHANNEL A/D CONVERTER
MICRO-PROCESSOR Z-80
CLOCK
NON-MASKABLE INTERRUPT
COUNTERS
TO AUX BOARD
MASKABLE INTERRUPT
EXTERNAL OPTION SELECTION
OPTION SELECTION (DIP SWITCH)
TO AUX BOARD
REFERENCE VOLTAGE GENERATOR
+VREF
-VREF
VREF ADJUST
TO AUX BOARD
TO AUX BOARD
LOGIC CONTROL
POWER SUPPLY & REGULATORS
+5V
DIGITAL GND
+15V
-15V
ANALOG GND
PROGRAM EPROM STORAGE
RAM STORAGE
LATCH & DRIVERS
M.T.O (UNCONTROLLED)
ALARM HIGH
ALARM LOW
ALARM
TO DISPLAY BOARD
VOLTAGE LEVEL ADJUST
M.T.O INTERRUPT
I/O INTERRUPT
FROM AUX BOARD
PROPRIETARY NOTICE
= PARAMETER POT (USER ADJUSTABLE)
= CALIBRATION POT
DWG NO 47126
SH 1-1
REV
REVISIONS
ZONE
REV
DESCRIPTION
DATE
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PARTS LIST
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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE FRACTIONS DECIMALS ANGLES
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P I 5200 MAIN BOARD
SIZE
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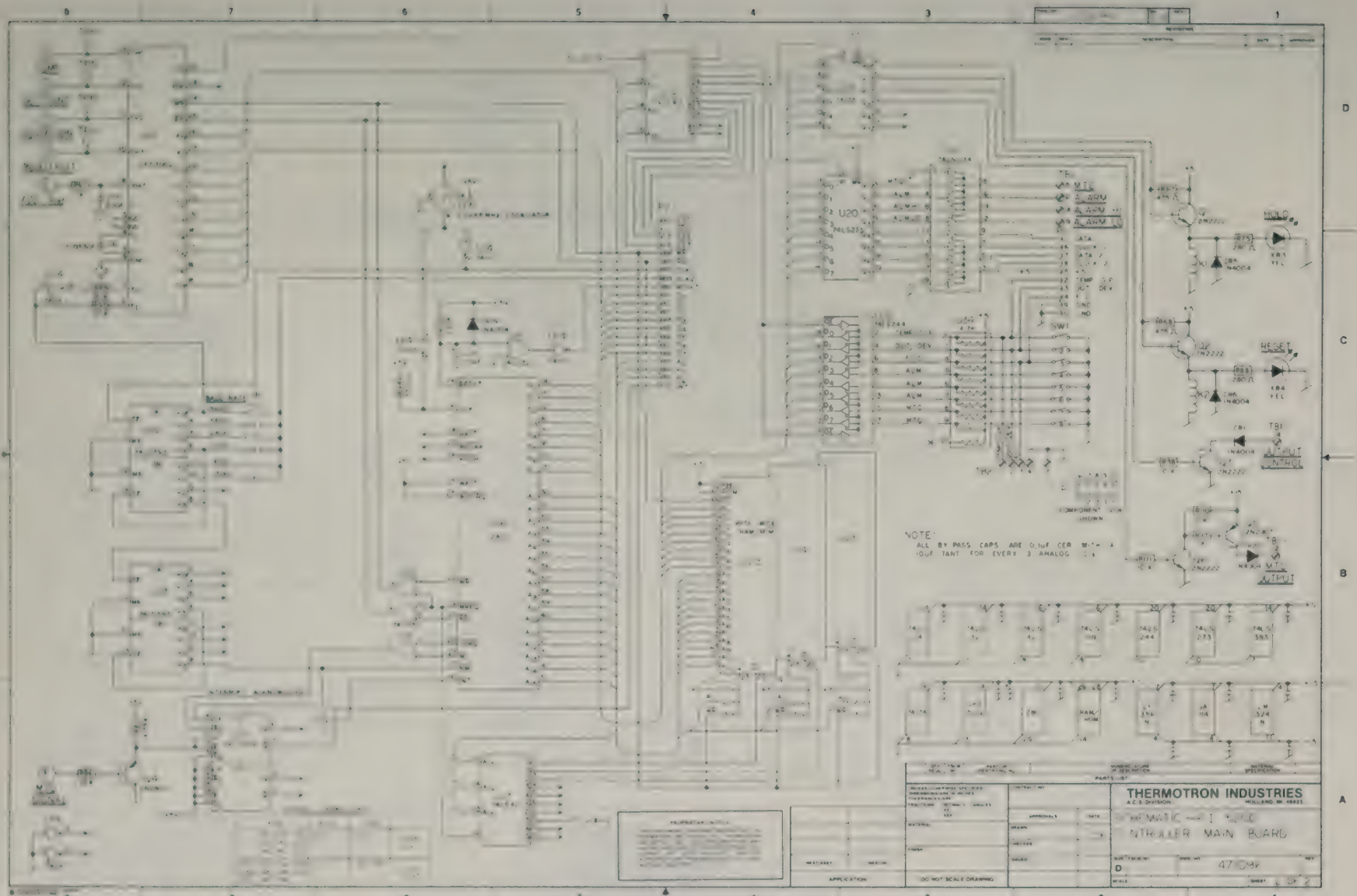
SHEET 1 OF 1


NOTE:
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10uF TANT FOR EVERY 3 ANALOG
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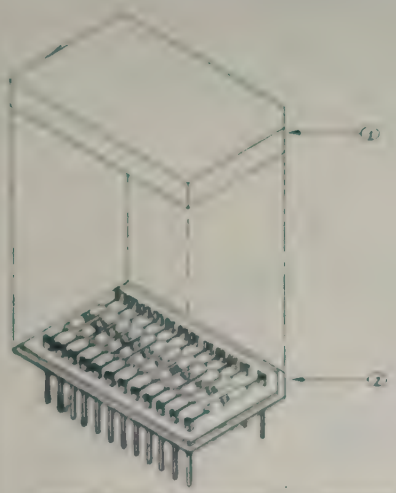
HOLLAND, MICHIGAN 49423



RL		RESISTOR	
RK			
RJ			
RI			
RH			
RG			
RF			
RE			
RD			
RC			
RB			
RA		RESISTOR	
2	637832	DIP PLUG	
1	677473	DIP COVER	
677072	471090-16	RANGE -40° C TO +60° C	TYPE T

RL	052936	RESISTOR	23.2 K
RK			143 K
RJ	052516		40.2 K
RI	052459		10 K
RH	052401		0 K
RG	052406		10 K
RF	052410		20 K
RE	052539		332 K
RD	052570		10 M
RC	052703		1 K
RB	052701		1 K
RA		RESISTOR	
2	637832	DIP PLUG	
1	677473	DIP COVER	
680959	471090-15	RANGE 0 to 400° F	Type "J"

RL		RESISTOR	
RK			
RJ			
RI			
RH			
RG			
RF			
RE			
RD			
RC			
RB			
RA		RESISTOR	
2	637832	DIP PLUG	
1	677473	DIP COVER	
677272	471090-12	EVEN INPUT 0 TO 20 mA	

RL	052936	RESISTOR	23.2 K
RK			143 K
RJ	052516		40.2 K
RI	052459		10 K
RH	052401		0 K
RG	052406		10 K
RF	052410		20 K
RE	052539		332 K
RD	052570		10 M
RC	052703		1 K
RB	052701		1 K
RA		RESISTOR	
2	637832	DIP PLUG	
1	677473	DIP COVER	
680931	471090-14	RANGE 0 TO 400° F	TYPE "K"

RL		RESISTOR	
RK			
RJ			
RI			
RH			
RG			
RF			
RE			
RD			
RC			
RB			
RA		RESISTOR	
2	637832	DIP PLUG	
1	677473	DIP COVER	
677264	471090-11	EVEN 1 INPUT 4 TO 20 mA	

RL	052449	RESISTOR	27.4 K
RK			OPEN
RJ	649906		40.2 K
RI	052347		3.01 K
RH			10 K
RG	052401		10 K
RF	052430		80 K
RE	052569		1 M
RD	051080		10 M
RC			.05 K
RB	052303		.1 K
RA		RESISTOR	OPEN
2	637832	DIP PLUG	
1	677473	DIP COVER	
687561	471090-13	RANGE -65° C TO 400° C	TYPE T

RL		RESISTOR	
RK			
RJ			
RI			
RH			
RG			
RF			
RE			
RD			
RC			
RB			
RA		RESISTOR	
2	637832	DIP PLUG	
1	677473	DIP COVER	
677072	471090-16	RANGE -40° C TO +60° C	TYPE T

NOTES:
1. ALL RESISTORS ¼W 1%
2. [illegible]
3. [illegible]
4. WRITE P.N. ON STICK LABEL AND [illegible] ON COVER

THERMOTRON INDUSTRIES
A.C.S. DIVISION
HOLLAND, MI 49423

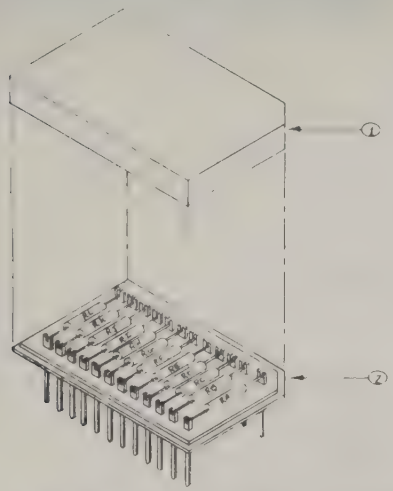
5200 [illegible]
RESISTANCE MUX

D 471090 A

SCALE 3/4

471090 INITIAL

REVISIONS			
A	RELEASED		



1	RL	052432	RESISTOR	21.0 K
1	RK	—		OPEN
1	RJ	052516		143. K
1	RI	052459		40.2 K
1	RH	052401		2 K
1	RG	052401		2 K
1	RF	052430		20 K
1	RE	052569		511 K
1	RD	052401		1.0 M
1	RC	052303		1.05 K
1	RB	052303		1.05 K
1	RA	—	RESISTOR	OPEN
1	2	657832	DIP PLUG	
1	1	678473	DIP COVER	
		677108	471090-07	TYPE T T/C INPUT 0°F TO 40°F

1	RL		RESISTOR	16.5 K
1	RK			OPEN
1	RJ			2.1 K
1	RI			402 K
1	RH			10 K
1	RG			1.0 K
1	RF			2.0 K
1	RE	052569		511 K
1	RD	051080		1.0 M
1	RC	052303		1.05 K
1	RB	052303		1.05 K
1	RA		RESISTOR	—
1	2	657832	DIP PLUG	
1	1	678473	DIP COVER	
		671094	471090-06	TYPE T T/C INPUT -78°C TO +278°C

1	RL	052469	RESISTOR	49.9 K
1	RK			OPEN
1	RJ	052512		130 K
1	RI	052459		40.2 K
1	RH	052401		2 K
1	RG	052401		2 K
1	RF	052430		20 K
1	RE	052569		511 K
1	RD	051080		1.0 M
1	RC	052303		1.05 K
1	RB	052303		1.05 K
1	RA	—	RESISTOR	OPEN
1	2	657832	DIP PLUG	
1	1	678473	DIP COVER	
		673056	471090-02	TYPE T T/C INPUT -78°C TO +93°C

	RL		RESISTOR	
	RK			
	RJ			
	RI			
	RH			
	RG			
	RF			
	RE			
	RD			
	RC			
	RB			
	RA		RESISTOR	
1	2	657832	DIP PLUG	
1	1	678473	DIP COVER	
		677124	471090-09	EVEN INPUT 0 TO 1 V DC

1	RL	052200	RESISTOR	0 Ω
1	RK	—		OPEN
1	RJ	052501		100K
1	RI	052501		100K
1	RH	052200		0 Ω NOTE JUMPER "H" BETWEEN PINS 17 & 23
1	RG	—		OPEN
1	RF	052200		0 Ω NOTE CUT OFF IC UNUSED PIN FOR THIS RANGE
1	RE	052303		1.05K
1	RD	—		OPEN
1	RC	052303		1.05K
1	RB	—		OPEN
1	RA	—	RESISTOR	OPEN
1	2	657832	DIP PLUG	
1	1	678473	DIP COVER	
		673080	471090-05	EVEN INPUT 0 to 5 VDC INPUT

	RL		RESISTOR	
	RK			
	RJ			
	RI			
	RH			
	RG			
	RF			
	RE			
	RD			
	RC			
	RB			
	RA		RESISTOR	
1	2	657832	DIP PLUG	
1	1	678473	DIP COVER	
		677116	471090-03	EVEN INPUT 1 TO 5 V DC

1	RL	052200	RESISTOR	0 Ω
1	RK	—		OPEN
1	RJ	052501		100K
1	RI	052501		100K
1	RH	052303		1.05K NOTE JUMPER "H" BETWEEN PINS 7 & 23
1	RG	—		OPEN
1	RF	052200		0 Ω NOTE CUT OFF IC UNUSED PIN FOR THIS RANGE
1	RE	052470		52.3K
1	RD	—		OPEN
1	RC	052303		1.05K
1	RB	—		OPEN
1	RA	052201	RESISTOR	100 Ω
1	2	657832	DIP PLUG	
1	1	678473	DIP COVER	
		673097	471090-04	EVEN INPUT 0 to 1 mA INPUT

1	RL	052479	RESISTOR	3 K
1	RK			OPEN
1	RJ	052512		130K
1	RI	052469		49.9K
1	RH	052401		2K
1	RG	052401		10K
1	RF	052439		20K
1	RE	052469		51K
1	RD	[illegible]		1M
1	RC	052303		1.05K
1	RB	052303		1.05K
1	RA	—	RESISTOR	OPEN
1	2	657832	DIP PLUG	
1	1	678473	DIP COVER	
		673[illegible]	471090-[illegible]	[illegible]

NOTES:
1. ALL RESISTORS ¼W 1% UNLESS OTHERWISE NOTED
2. SOLDER RESISTORS DOWN (24 PL.)
3. GLUE COVER DOWN
4. WRITE P.N. ON STICKY LABEL AND STICK ON COVER

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PARTS LIST

THERMOTRON INDUSTRIES
HOLLAND, MI. USA

5200 PROGRAMMABLE RESISTANCE BOX

D			471090

SCALE: 3/4

5200 CONTROLLER MAIN BOARD PARTS

	DESIGNATION	PART NO.
CAPACITORS:	C1	067001
	C2,13,14,15	067003
	C3,5	062014
	C4	067002
	C6	657891
	C7	629693
	C8,10,16,17, 18,25,26,28, 31,33,35,37, 40,41,42,43	062008
	C9,11	640417
	C12,19,20,27, 29,30,32,34, 36,38,39,44, 45,46,47,48	067003
DIODES:	CR1,5,6,7,8, 9,10,11,12, 16,17,19,20	081004
	CR2,3,4,13, 14,15,18,21	081020
RELAYS:	K1,2	649716
MISCELLANEOUS:	14 Pin Socket (13)	175004
	16 " " (4)	175006
	24 " "	175007
	8 " "	175008
	28 " " (4)	175019
	20 " " (3)	175032
	40 " "	175034
TRANSISTORS:	Q1,2,3,6	649961
	Q4,5	083016
RESISTORS:	R1,2,84,91,93, 96,100,101, 105,106,107, 108,109	052301
	R3	052385
	R4,14,23,24, 64	052501
	R5	052481
(pot)	R6,9,31,74	054033
	R7	052543
	R8	052495
	R10,11,17,18, 34,35,36,38, 51,52,55,56, 59-62,77-79, 81,82,86,89, 90,97, 99, 102,104, 110-115	052401

	DESIGNATION	PART NO.
RESISTORS Continued:	(pot) R12,16,19,95	054045
	R20,21	052530
	R22,33,76,83	052430
	R25,66	052439
	R26,69	052518
	R27,70	052434
	(pot) R28,49,53,54, 57,71	629669
	R29,72	052601
	R30,67,68,73	052266
	R32,85	052468
	R37,80	051082
	R39,41	051471
	R40	051069
	R42	051074
	R43	051077
	R44	051079
	R45,46	051481
	R47	052169
	R48,50	052388
	R58	052545
	R63,65	052522
	R75,88	052244
	R87	052366
	R92	052534
	R94	052251
	(pot) R98,103,116, 117	054035
SWITCHES:	SW1	642878
	SW2	625175
INTEGRATED CIRCUITS:	U10	547859
	U11	657867
	U12,13	629057
	U14	091005
	U15	629065
	U16	657875
	U17,18	192010
	U19	091009
	U20	629634
	U21,22	634425
	U23	675466
	U25	630381
	U27	091025
	U28	093044
	U29	093035
	U30	093036
	U31	678481
	U32	629898
	U33	658014
	U34	055007
	U35-43	093019

	DESCRIPTION	PART NO.
ZENER:	VR2-5	629111
L.E.D.:	XR1	081015
	XR2	081017
	XR3,4	657905

SPARE PARTS AND RETURN OF MATERIALS

SPARE PARTS:

Thermotron does not recommend that you keep a supply of parts on hand because the nature of any failure is random. If there were patterns to failures, design changes would have been made. However, a complete listing of parts is provided immediately following the drawings.

RETURN OF MATERIALS:

In the event that you have a Thermotron instrument that has failed under warranty, or an instrument which requires repair, call the Controls Department at Thermotron. You will be given an R.M.T. (Return Material Tag) number and authorization for the return of the item. The number should be marked boldly on the outside of your package as well as recorded on your packing slip. When contacting the Controls Department, the following information is required:

1. The complete part number.
2. The model number and serial number, if available, of the Thermotron instrument.
3. The specific complaint regarding failure.
4. A purchase order number is preferred and, in many cases, required.

A telephone number and contact person should be listed on your packing slip so that we know who to contact in case of a question. For warranty replacement, you will be invoiced upon the date of shipment, and you will be issued credit on that invoice upon our receipt of the defective item.

IT IS IMPORTANT THAT YOU IDENTIFY THE ITEM
WITH THE R.M.T. NUMBER WHICH IS ASSIGNED.

Warranty service is provided without charge; non-warranty service is done on a time-plus-material basis.

Please address the shipment and any related paperwork to:

THERMOTRON INDUSTRIES, INC.
ACS Factory Service
Kollen Park Drive
Holland, MI 49423
Phone: (616) 392-1491

S T A G I N G

S Y S T E M

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M A N U A L

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THERMOTRON INDUSTRIES

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- Schematics, Parts Lists, Layout Drawings

- Spare Parts and Return of Materials

1.0 GENERAL DESCRIPTION

The staging system consists of a power board and a staging board. These boards can be mounted in a 2 3/4 inch wide relay track. They are connected together via wiring to terminal blocks. The power board converts 115 VAC to ±15 VDC for the system use. The staging board accepts one or two analog throttle inputs, and converts them to time proportional outputs. The input types can be current or voltage, and are programmable by means of a resistor header box. There are 4 stages of output which can be used. The standard fashion is to use two heat outputs and two cool outputs, but other configurations are also possible such as 4 - stage - cool time proportioning outputs. The outputs are switch selectable for different cross-over stages. Each pair of stages has a switch which can select one of four possible cross-over points. Along with the 4 stages of throttle outputs are included a machine time out signal and a bypass signal (a complement of the high cool signal). The time out signal can be triggered by one of two stages, or from an external signal. Each one of the 6 output signals (4 stages, MTO, and bypass) are connected to solid state relays. These relays can switch 120 VAC at up to 1.5 amps.

The staging system may be used in conjunction with the 5200 controller, or it may be ordered for use in other design configurations. Therefore, it is assigned a separate number from the 5200 (see 2.0, configurations).

2.0 CONFIGURATIONS

A. Number of Input Signals

1. One input signal
2. Two input signals

B. Input Range Cool

1. + 0 to -10 Volts
2. + 0 to - 5 Volts
3. + 0 to + 5 Volts
4. + 1 to + 5 Volts
5. + 4 to +20 mA
6. + 4 to +12 mA

C. Input Range Heat

1. + 0 to +10 Volts
2. + 0 to - 5 Volts
3. + 0 to + 5 Volts
4. + 1 to + 5 Volts
5. + 4 to +20 mA
6. +12 to +20 mA

D. Stage Crossover Cool

1. 15/20/25/100 (5/4/3/0:1)

E. Stage Crossover Heat

1. 25/35/50/100 (3/2/1/0:1)

ORDERING EXAMPLE: 662410-1-1-1-1-1
This is the standard staging board, as one would order it to go with the 5200 system controller. It has only one bi-directional input throttle. The heat signal is 0 to +10 VDC. The cool signal is 0 to -10 VDC. The standard crossover options are selected. A dip switch selects which crossover points are used.

3.0 SPECIFICATIONS

-Input:	See option selection for the different ranges available in both current and voltage, one channel uni-directional, or two channel
-Time-Base:	Adjustable 0.3 to 20 seconds, independent adjustments for heat and for cool
-Remote Shut-Down:	All SSR's can be shut down by means of external contact switching of the SSR common.
-Solid-State Relays:	Six SSR's rated at 140 VAC 1.5 A to switch each of the 4 stages, bypass, and MTO
-LED:	Six LED's indicate the status of each SSR
-MTO:	Adjustable machine time out, 20 to 120 seconds.
-Staging:	4 independent staging points for heat and cool. Values are programmable via a resistance box. 4 values on each box for heat and cool. One of the 4 values is selected by dip switch.
-Power:	115 VAC, 50/60 Hz, ±10%
-Operating Temp:	0 to 50 degrees C (32 to 122 F)
-Mechanical Mounting:	2 3/4 inch wide relay track, or #6 studs 12 inch staging board 4 inch power board

4.0 TERMINAL BLOCK IDENTIFICATION

4.1 POWER BOARD

Terminal Block 1 (TB1)

1 - (+) 15 VDC Output
2 - Ground
3 - (-) 15 VDC Output

Terminal Block 2 (TB2)

1 - 115 Line Input
2 - 115 Neutral Input
3 - Earth Ground

4.2 STAGING BOARD

Terminal Block 1 (TB1)

1 - (+) 15 VDC Input
2 - Ground
3 - (-) 15 VDC Input

Terminal Block 2 (TB2)

1 - Heat Signal Input
2 - Heat Signal Common
3 - Cool Signal Input
4 - Cool Signal Common
5 - SSR Common
6 - Ground
7 - MTO Control Input

Terminal Block 3 (TB3)

1 to 2 - High Heat Switch
3 to 4 - Low Heat Switch
5 to 6 - Low Cool Switch
7 to 8 - High Cool Switch
9 to 10 - Bypass Switch
11 to 12 - Compressor MTO Switch

5.0 CIRCUIT DESCRIPTION

The following descriptions explain the workings of both the power board and the staging board.

5.1 POWER BOARD

The output of transformer T1 is rectified, filtered, and supplied to U1 and U2, +15 Volt and -15 Volt regulators for use by the staging board.

5.2 STAGING BOARD

The staging board contains two nearly identical independent circuits. Generally, one circuit is used for heat staging, and the other for the cool staging. The cool staging has additional circuitry to provide bypass and MTO functions. A description is provided for the cool circuitry, and a direct analogy can be made to the heat circuitry (see drawing 471101).

5.2.1 INPUT

The cool signal enters via TB2-3, with common on TB2-4. The analog signal is amplified by U8B, the gain of which is determined by U3, a programmable resistor header. U8D inverts the amplified input signal. The source of the input to comparators U7A and U7B is selected by jumper J8, as determined by the polarity of the cool throttle input (see section 7, JUMPER SET-UP).

5.2.2 SAW-TOOTH GENERATOR

To create the time pulses to drive the outputs, a saw-tooth wave is generated to combine with the throttle input. The wave is generated by U5A and U5D. The amplitude of the cycle is set by R5, a 25 turn pot. The cycle rate is set by R4, a user adjustable one turn pot. The output of U5D, a ±2.5 volt saw tooth, along with an offset voltage selected by J4, are summed by U5B, an inverting summer amplifier. The position of Jumper J4 selects a 0 to +5 V. sawtooth or a 0 to -5 V. sawtooth (see section 7).

5.2.3 DUAL SCALED SAWTOOTH GENERATOR

The 0 to ±5V. sawtooth is provided to low cool inverting amplifier U7C and to high cool inverting amplifier U7D. The gain of each is determined by resistors selected by positions of dip switch SW2. Jumper J1 in position 1 or 2 selects a (-) or (+) bias voltage which, in conjunction with a resistor selected by a position of SW2, determines the crossover between low and high cool when combined with the sawtooth voltage by U7D (See section 7.)

NOTE: That the gain resistors are all mounted in U2, a programmable resistor header, for ease of inter-changeability. The outputs of U7C and U7D are now at the

proper scales to be compared to the input signal. (The crossover concept is explained in section 8, USER OPERATION.)

5.2.4 COMPARATOR AND DRIVE CIRCUITS

The input signal from U8B and U8D and the low cool sawtooth signal of U7C are compared by U7B. As the sawtooth signal goes more positive than or more negative than the input signal, the comparator saturates low or high. This is the low cool output which operates low cool SSR3 when U7B output is high. The input signal is also compared to the biased sawtooth of U7D by high cool comparator U7A. When U7A output is high, relay SR3, the high cool relay is operated. The low cool and high cool signals to SSR3 and SSR4 are filtered, passed through current directing diodes, and low cool and high cool L.E.D.'s which provide a visual indication of circuit action.

5.2.5 BYPASS SIGNAL

To provide a bypass signal to drive a refrigerant bypass solenoid, either the high cool or the low cool signal is inverted as selected by Jumper J5. (See section 7). Usually the high cool signal is inverted so jumper J5 would be in position 1. U9B provides this function by comparing the selected cool signal to ground. When the signal is negative indicating not high cool, the output of U9B is positive indicating bypass or not high cool. This signal passes through a diode and an L.E.D. to operate SSR5, the bypass relay.

5.2.6 MACHINE TIME OUT SIGNAL

The machine time out (compressor) signal may be generated external to this circuit. In that case, with Jumper J6 in position 2, the signal is received via TB3-7, is directed through diode CR8 and L.E.D. MTO, and operates relay SSR6 directly. XR6 lit indicates SSR6 is operated and the compressors are operating.

With Jumper J6 in position 1, the signal is generated internally. The low cool output of U7B is monitored by comparator/inverter U9A. With a cool signal present, integrator timing capacitor C17 is discharged and there is no output from integrator U9D and no input on the non-inverting input of U9C. The negative bias on the inverting input of U9C provided by the voltage divider including R17 causes a high output. When the output of U9C is high, relay SSR6 operates through CR8 and L.E.D. XR6 indicating that the compressors are needed as cooling is required.

With no cool signal present, the output of U9A is high and integrator timing capacitor C17 begins to charge. The charging continues as long as a cool signal does not reset the integrator. When the voltage applied to U9C is sufficient to overcome the bias, U9C output goes low, XR6 goes out, SSR6 releases, and the compressors shut down.

6.0 ALIGNMENT AND CALIBRATION

EQUIPMENT NEEDED:
-Digital volt meter with .001 volt resolution
-Voltage or current signal source corresponding to input range.
precision voltage source, resolution .001 volts
precision current source, resolution .01 mA
-Misc. jumper wires
-Oscilloscope 50 mV/div A/C range, 2V/div D/C range
-115 volt power cord and variable supply

> C A U T I O N
>
> Hazardous potentials exist on the circuit board when power is applied. Use extreme caution when calibrating.

NOTES:
Tests performed with the oscilloscope and the variable supply may be omitted if the unit is being realigned after initial calibration.

Refer to schematic 471101, and to 471113 drawing for guide to parts locations when calibrating.

Install jumpers per section 7 in accordance with required staging circuit operating condition

If the unit has been working correctly, and only the critical input functions need calibrating, only a 4½ digit DVM and an input signal source is needed. Perform steps 6.2.1, 6.2.2, and 6.2.4. This will calibrate the critical points necessary for proper operation. The other tests are operational checks to verify correct operation of the boards. If this unit is operating with a 5200 Controller, the manual output feature can be the input signal source. Using the D.V.M. measure the signal from the 5200 at TB2, the appropriate terminals. Note that the manual output has the greatest resolution if R53 and R54 on main board are full C.W.

6.1 POWER SUPPLY

1. Connect the scope and DVM ground leads to TP3
2. Connect the power line, neutral, and earth wires to the power board, and plug in to variable power source.
3. Apply 115 volts AC to the unit.
4. Connect DVM (+) lead to TP1; should be (S.B.) +15 VDC ±0.6 VDC
5. Connect scope (+) lead to TP1; S.B. less than 30 mV AC noise
6. Vary the AC power supply from 100 to 130 VAC; readings of steps 4 and 5 valid.
7. Connect DVM (+) lead to TP2; S.B. -15 VDC ±0.6 VDC

6.1 POWER SUPPLY Cont.

8. Connect scope (+) lead to TP2; S.B. less than 30 mV AC noise.
9. Vary the AC power supply from 100 to 130 VAC; readings of steps 7 and 8 valid.

6.2 STAGING BOARD CALIBRATION

10. Connect the power board to the staging board by interconnecting TB1-1,2,&3 on the power board to TB1-1, 2, & 3 on the staging board. The short jumper wires can be used. Apply power with DVM (-) on TB1-2. Verify the ±15 volt supply to TB1-1 (+15 VDC) and TB1-3 (-15 VDC).

6.2.1 REFERENCE VOLTAGE CALIBRATION

11. Connect the DVM (-) to TB1-2. Connect DVM (+) lead to TP2 on the staging board. Adjust R1 for 5.000 VDC ±.001 VDC.
12. Connect the DVM (+) lead to TP1 and check for -5.00 VDC ±.03 VDC. There is no adjustment for this voltage.

6.2.2 INPUT HEAT CALIBRATION

13. Connect input signal source (+) to TB2-1 and the (-) to TB2-2.
14. Provide input signal corresponding to zero heat throttle and adjust R16 for 0.00 VDC ±.01 VDC at TP5 if J7 jumper is in position 1, or U8 pin 8 if J7 jumper is in position 2.

6.2.3 HEAT CYCLE CALIBRATION

15. Place SW1 position 1 in the UP position (toward the number) and positions 2, 3, and 4 down. Place a jumper between TB2-5 and TB2-6. Check again for 0.00 VDC as in step 14.
16. Watch XR2, the red low heat LED. Adjust R2 so the LED just stops flashing.
17. Change the input signal to match the percentage of switch 1 position 1. This is the first number listed on U1, right above the switch. (standard is 25%). The input is linear. Example: if 0 to +10 VDC is heat input, 25% = +2.5 VDC. Verify that XR2 on 100% and high heat just barely beginning to light.
18. Repeat step 17 for each of SW1 positions 2, 3, and 4 to verify proper cross-over operation.

6.2.4 INPUT COOL CALIBRATION

19. Connect input signal source (+) to TB2-3 and the (-) to TB2-4.
20. Provide input signal corresponding to zero cool throttle and adjust R15 for 0.00 VDC ±.01 VDC at TP4 if J8 jumper is in position 2, or U8 pin 7 if J8 jumper is in position 1.

6.2.5 COOL CYCLE CALIBRATION

21. Place SW2 position 1inthe UP position, and positions 2, 3, and 4 down. Place a jumper between TB2-5 and TB2-6. Check again for 0.00 VDC as in step 20.
22. Watch XR3, the green low cool LED. Adjust R5 so the LED just stops flashing.
23. Change the input signal to match the percentage of switch 2 position 1. The percentage is listed on U2, right above the switch (same procedure as in step 17). Verify that XR3 ON 100% and XR4, high cool is barely beginning to light.
24. Repeat step 23 for each of SW 2 positions 2, 3, and 4 to verify proper cross-over operation.

6.2.6 BYPASS VERIFICATION

25. If Jumper J5 is in position 1, adjust input signal to cause XR4 high cool LED to pulse on and off, or with jumper J5 in position 2, cause XR3 low cool LED to pulse on and off.
26. Watch XR5, the yellow bypass LED, and check for opposite operation compared to XR3/XR4.

6.2.7 MACHINE TIME OUT (J6 Position 1)

27. If jumper J5 is in position 1, adjust the input to cause XR4 LED to light, or with jumper J5 in position 2, cause XR3 to light. Verify that XR6 is lit. Adjust R17 full clockwise. With a watch or timer for reference (time's not critical) adjust input signal to extinguish XR3 and XR4. Neither must pulse on for this test. After approximately 20 seconds, XR6 should go out.
28. Repeat step 27 except adjust R17 full counter-clockwise. Time until XR6 extinguishes should be approximately 2 minutes.
29. Calibration is complete. Disconnect all leads and equipment which were added for these tests.

7.0 JUMPER PLACEMENT

Place jumpers as indicated in the following table for the polarity of input signal. The proper resistor boxes for the input, and heat and cool staged crossover points must also be installed. The connotation used with the jumpers is jumper number/position.

	CH1: (HEAT)	CH2: (COOL)
Positive going input = MORE throttle	J7/1 J3/1 J2/1	J8/2 J4/2 J1/2
Negative going input - MORE throttle	J7/2 J3/2 J2/2	J8/1 J4/1 J1/1

J5/1 for bypass action to coincide with HIGH cool
J5/2 for bypass action to coincide with LOW cool

J6/1 for MTO signal to be generated on the staging board
J6/2 for MTO signal to be controlled externally

For one channel operation, a short jumper is connected between TB2-1 and TB2-3. This jumper remains permanently.

EXAMPLE: 662410-1-1-1-1-1

This model has a cool input signal of 0 to -10 volts, and a heat input signal of 0 to +10 volts. Thus, the heat channel is positive going signal = more output throttle, and the cool channel is negative going signal = more output throttle. Since only one signal input is specified, the heat/cool signals are one -10 to +10 volt signal. Thus, the heat/cool inputs on TB2-1 and TB2-3 are jumpered together with a short wire jumper. Jumpers J5 and J6 are selected as desired.

8.0 USER OPERATION

The user adjustments on the staging board are as follows:

1.	Cycle rate heat	1 turn pot R3
2.	cycle rate cool	1 turn pot R4
3.	Machine time out	1 turn pot R17
4.	Heat cross-over	4 position dip switch SW1
5.	Cool cross-over	4 position dip switch SW2

See drawing 471111 for component locations.

The cycle rate adjustments for heat and cool (C.W. - fast; C.C.W. - slow) determine the rate at which the heat and cool stages pulse. Note the independent adjustments for heat and cool. The heat setting sets both the high and low heat pulse rate, and the cool sets both the high and low cool pulse rates. When this board is used in conjunction with another controller, such as the 5200 system, the pulse rate adjustments of this circuit are used.

The machine time-out period is adjustable from about 20 seconds (C.W.) to approximately 120 seconds (C.C.W.). When J6 is in position 1, this adjustment controls the period of time with no cooling demand before relay SSR6 shuts down the compressors. With J6 in position 2, the control of the relay is determined by an external MTO signal (input on TB2-7), not by the cooling demand of the staging board. For instance, the 5200 controller has an MTO output, or with the computer I/O option installed on the 5200, the computer can control the compressor operation. When using the external MTO signal, R17 has no effect on the compressors.

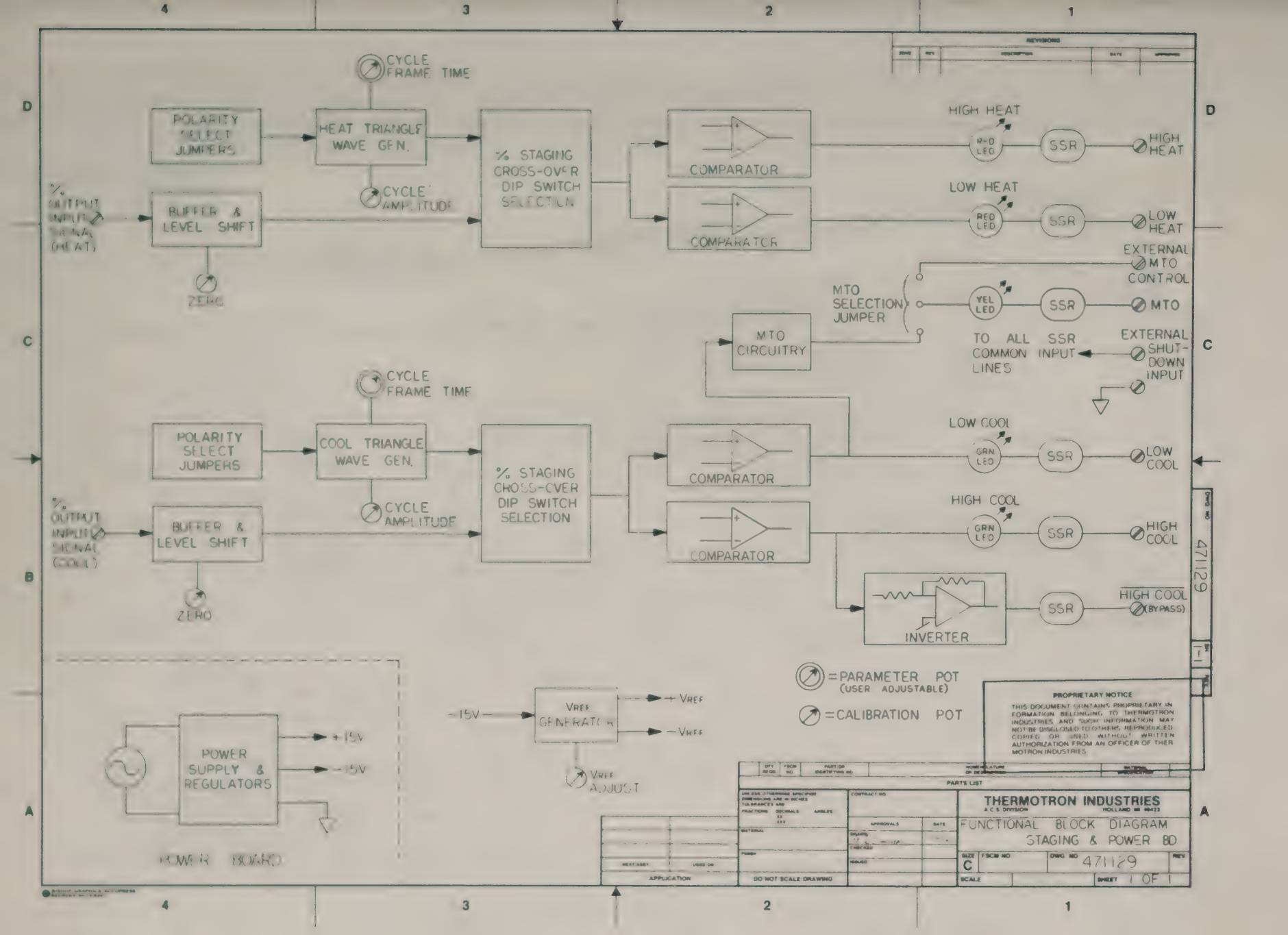
SSR1-6 relays all have their commons tied to TB2-5. TB2-5 is grounded by connecting it to TB2-6 unless the ability to disable the SSR's from an external source is desired. This ability can be implemented with the 5200 system, for instance, by connecting the SSR common output of the 5200 controller to TB2-5. This will provide open thermocouple protection, shutting all the SSR contacts off in the event of an open T/C. It also provides master on-off control via the computer I/O board of the 5200 system.

The staging board has independent staging control of the heat and the cool cross-over points with a dip switch provided for each channel. Each dip switch has a one-of-four selection which selects the cross-over point. The cross-over points available are listed on the programmable resistor header directly above the switch. Only one point is to be selected by the switches for each channel by placing the appropriate position in the UP position, pointing to the resistor header. The other 3 positions must be DOWN. The 4 user programmable cross-over points for each channel may be changed by replacing the resistor headers, U1 and/or U2.

The cross-over concept provides smoother process control than staging controlled by time delay relays. For example, a step change requiring heat is desired such that 100% heat output is needed. As the temperature rises towards setpoint time proportioning begins. With time delay relays, as soon as the throttle calls for less than 100% heat, the high heat timer resets causing an immediate removal of the high stage heaters from the control process. If the high/low heat ratio is 1:1, the heat output drops from 100% to 50% as soon as the temperature enters the proportional zone.

Using the cross-over concept, the same 1:1 high/low heat ratio (50% cross-over), a 0 to +10 VDC heat throttle, and a step change to a higher temperature, both high and low heat are on 100%. When the temperature rises and time proportioning begins, the low heat stage continues to provide full output but the high stage begins to pulse off and on depending on the heat throttle voltage and the pulse or cycle rate. When the throttle calls for 90% output, the low heat would be ON 100% and the high heat would be ON 80%, thus providing the required 90% heat. When the throttle reached +5 VDC indicating 50% throttle, the high heat would remain OFF and the low heat would begin to pulse ON and OFF. In this manner, a smooth transition can be obtained during proportioning.

The cool staging functions in the same fashion, although the high/low ratio for cooling is typically 4:1 giving a cross-over of 20%.


CYCLE FRAME TIME
POLARITY SELECT JUMPERS
HEAT TRIANGLE WAVE GEN.
% STAGING CROSS-OVER DIP SWITCH SELECTION
COMPARATOR
COMPARATOR
HIGH HEAT
R-D LED
SSR
HIGH HEAT
LOW HEAT
RED LED
SSR
LOW HEAT
% OUTPUT INPUT SIGNAL (HEAT)
BUFFER & LEVEL SHIFT
CYCLE AMPLITUDE
ZERO
EXTERNAL MTO CONTROL
MTO SELECTION JUMPER
YEL LED
SSR
MTO
MTO CIRCUITRY
TO ALL SSR COMMON INPUT LINES
EXTERNAL SHUT-DOWN INPUT
CYCLE FRAME TIME
POLARITY SELECT JUMPERS
COOL TRIANGLE WAVE GEN.
% STAGING CROSS-OVER DIP SWITCH SELECTION
COMPARATOR
COMPARATOR
LOW COOL
GRN LED
SSR
LOW COOL
HIGH COOL
GRN LED
SSR
HIGH COOL
% OUTPUT INPUT SIGNAL (COOL)
BUFFER & LEVEL SHIFT
CYCLE AMPLITUDE
ZERO
INVERTER
SSR
HIGH COOL (BYPASS)
=PARAMETER POT (USER ADJUSTABLE)
=CALIBRATION POT
POWER SUPPLY & REGULATORS
+15V
-15V
POWER BOARD
-15V
VREF GENERATOR
+VREF
-VREF
VREF ADJUST
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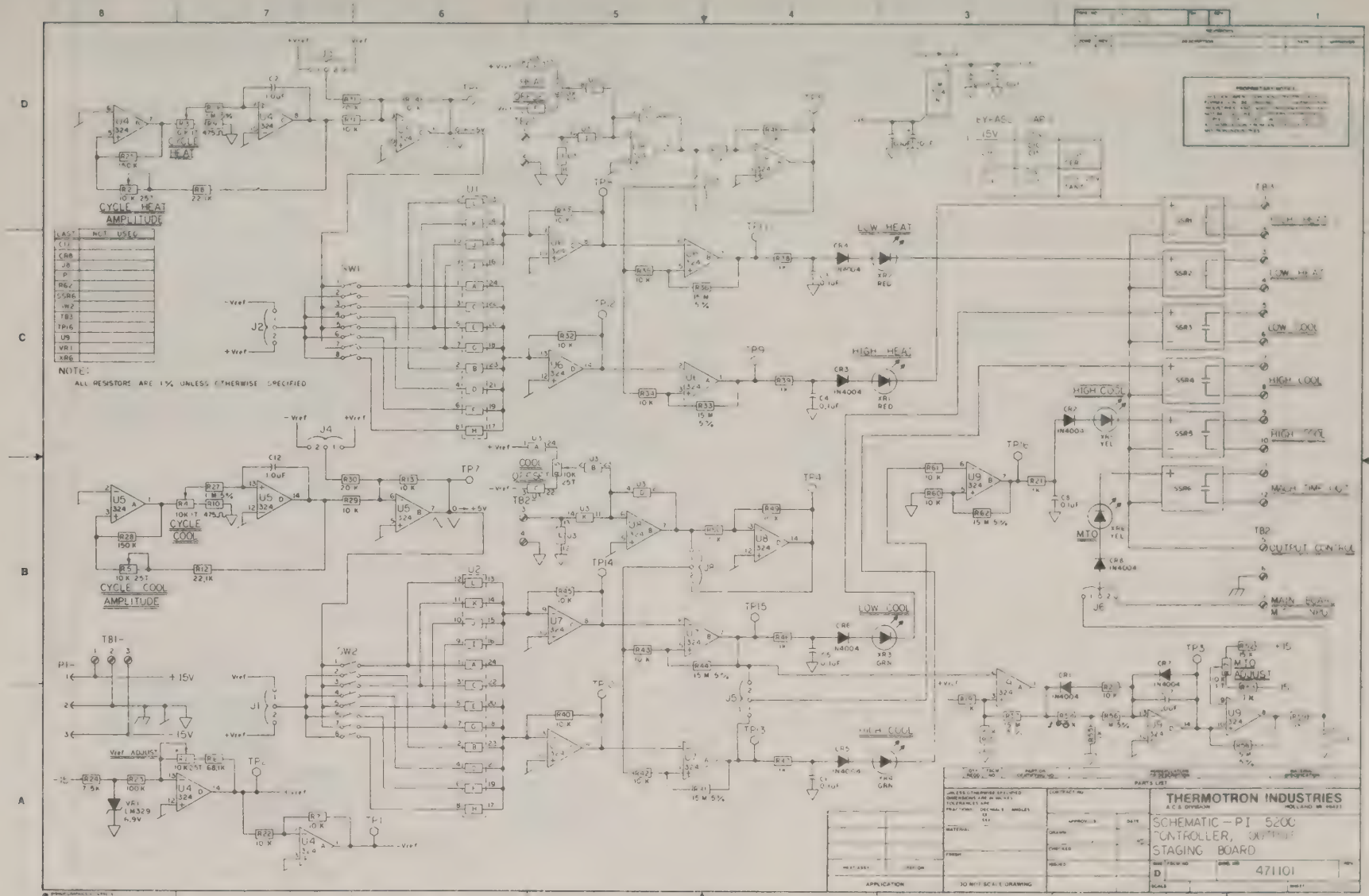
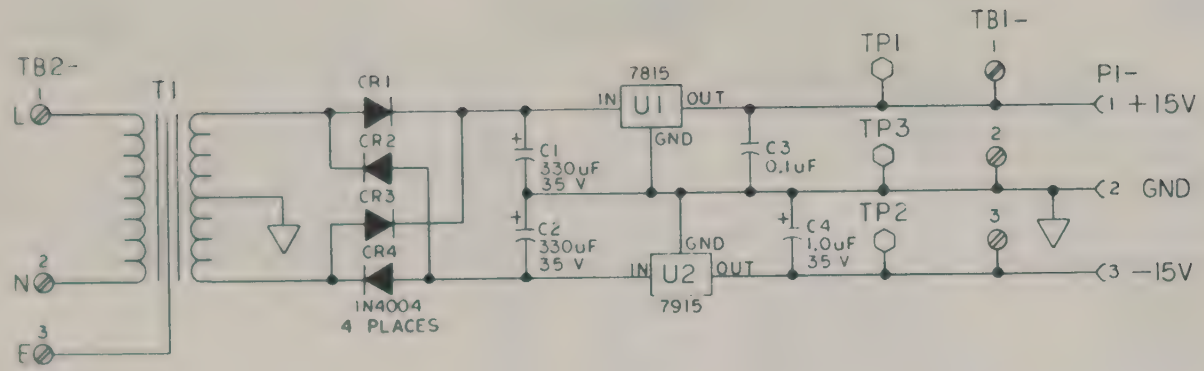
PARTS LIST
THERMOTRON INDUSTRIES
A C S DIVISION
HOLLAND MI 49423
FUNCTIONAL BLOCK DIAGRAM
STAGING & POWER BD
DWG NO 471129
SIZE C
SCALE
SHEET 1 OF 1
DO NOT SCALE DRAWING
APPLICATION
471129


CYCLE HEAT AMPLITUDE
CYCLE COOL AMPLITUDE
NOTE:
ALL RESISTORS ARE 1% UNLESS OTHERWISE SPECIFIED
LOW HEAT
HIGH HEAT
LOW COOL
HIGH COOL
MTO
MTO ADJUST
THERMOTRON INDUSTRIES
SCHEMATIC — PI 5200
CONTROLLER, OUTPUT
STAGING BOARD
471101



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SYM	DATE	CHANGE	BY	SYM	DATE	CHANGE	BY	MATERIAL	THERMOTRON CORP. HOLLAND, MICHIGAN U.S.A.
A				C					
B				D					

DRAWN BY	DATE	SCALE	APPROV.	DESCRIPTION	FOR	DRAWING NO	SH.
				SCHEMATIC — P I 5200 CONTROLLER POWER BOARD		471104	Y

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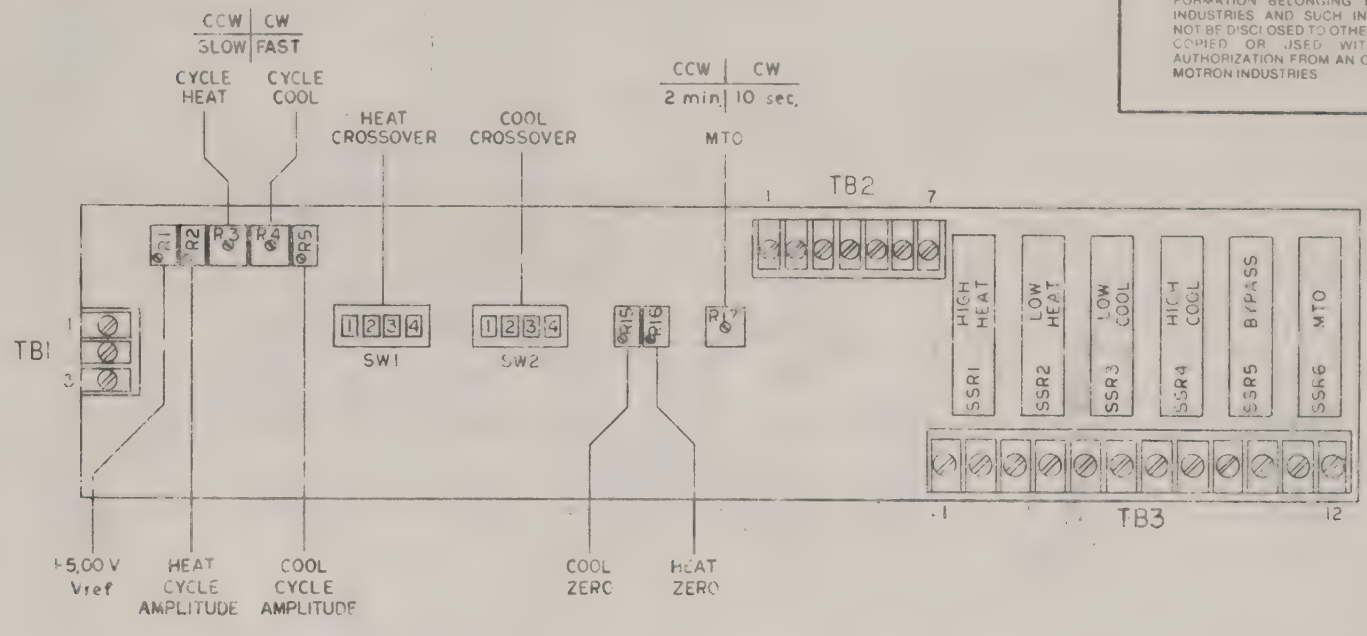
USER POTS



CALIBRATION POTS

SYM	DATE	CHANGE	BY	SYM	DATE	CHANGE	BY	MATERIAL	THERMOTRON CORP. HOLLAND, MICHIGAN U.S.A.
A				C					
B				D					

DRAWN	DATE	A.E.	APPROVED	DESCRIPTION	FOR	DRAW. NO.	
[illegible]	7/4/83			P.C. & SWITCH LOCATIONS—5200 STAGING BD		471208	Y

TP1 = + 15V
TP2 = − 15V
TP3 = GND

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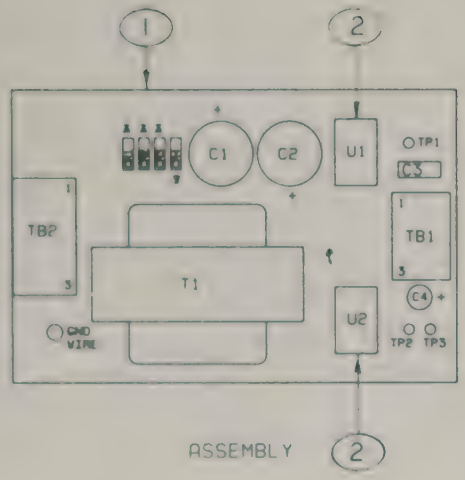


ITEM	QTY	COMPUTER NO.	DESCRIPTION	PART NO.
2	2	273011	HEAT SINK	
U2	1	093036	IC	7915
U1	1	093035	IC	7815
TP3	1	640077	J PIN	
TP2	1	640077	J PIN	
TP1	1	640077	J PIN	
TB2	1	658065	TERMINAL BLOCK	
TB1	1	666297	TERMINAL BLOCK	
T1	1	071001	TRANSFORMER	
CR4	1	081004	DIODE IN4004	
CR3	1	081004	DIODE IN4004	
CR2	1	081004	DIODE IN4004	
CR1	1	081004	DIODE IN4004	
C4	1	063002	CAPACITOR, TANT 1.0μF	
C3	1	062008	CAPACITOR, CER 0.1μF	
C2	1	640417	CAPACITOR, ELECT 330μF	
C1	1	640417	CAPACITOR, ELECT 330μF	
1	1	662380	PRINTED CIRCUIT BOARD	471105

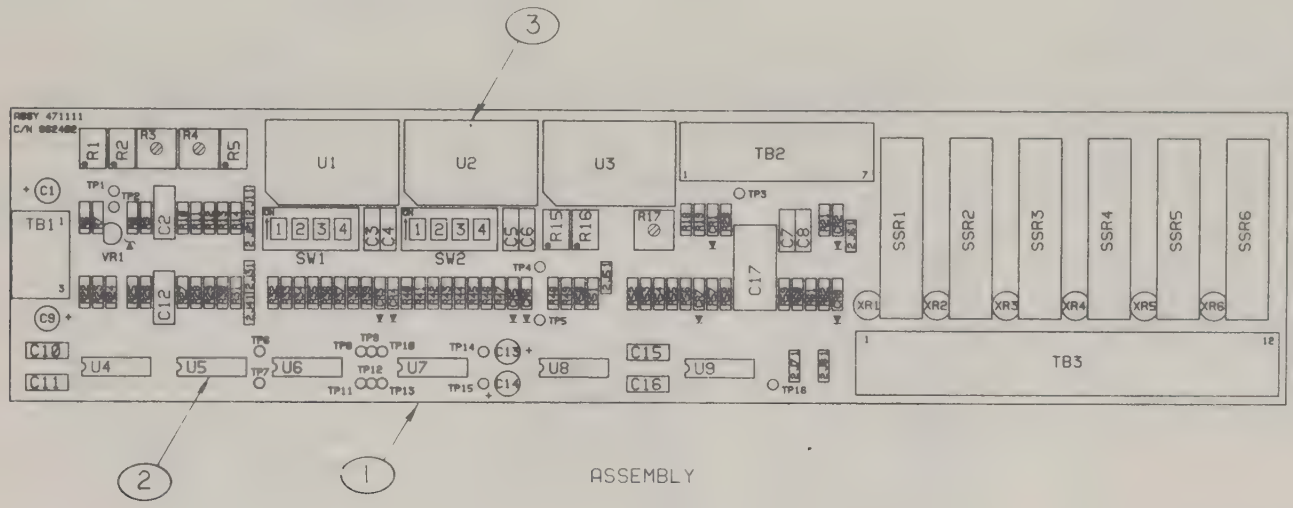
COMPUTER NO.
662399

SYM	DATE	CHANGE	BY	SYM	DATE	CHANGE	BY
A				C			
B				D			

MATERIAL

THERMOTRON CORP.
HOLLAND, MICHIGAN U.S.A.

DRAWN BY	DATE	SCALE	APPROV.	DESCRIPTION	FOR	DRAWING NO.	REV
A.C.	2/9/83	1:1		PCB ASSEMBLY - 5200 POWER BOARD		471103	Y



ASSEMBLY

ARTWORK GENERATED BY
TECHNICAL IND., INC.
J/N 599 (553)

SYM	DATE	CHANGE	BY	SYM	DATE	CHANGE	BY	MATERIAL	THERMOTRON CORP. HOLLAND, MICHIGAN U.S.A.
A				C					
B				D					

DRAWN BY	DATE	SCALE	APPROV.	DESCRIPTION	FOR	DRAWING NO.	
L. B.	2/18/83	1:1		PCB ASSEMBLY – 5200 STAGING BD.		471111	Y

SHEET 1 OF 3

ITEM	QTY	COMPUTER NO.	DESCRIPTION	PART NO.
R25	1	052518	RESISTOR 150K 1%	
R24	1	052385	RESISTOR 7.5K 1%	
R23	1	052501	RESISTOR 100K 1%	
R22	1	052401	RESISTOR 10K 1%	
R21	1	052301	RESISTOR 1K 1%	
R20	1	052401	RESISTOR 10K 1%	
R19	1	052401	RESISTOR 10K 1%	
R18	1	052401	RESISTOR 10K 1%	
R17	1	629669	POT. 10K 1T	
R16	1	054033	POT. 10K 25T	
R15	1	054033	POT. 10K 25T	
R14	1	052401	RESISTOR 10K 1%	
R13	1	052401	RESISTOR 10K 1%	
R12	1	052434	RESISTOR 22.1K 1%	
R11	1	052401	RESISTOR 10K 1%	
R10	1	052266	RESISTOR 475Ω 1%	
R9	1	052266	RESISTOR 475Ω 1%	
R8	1	052434	RESISTOR 22.1K 1%	
R7	1	052401	RESISTOR 10K 1%	
R6	1	052481	RESISTOR 68.1K 1%	
R5	1	054033	POT. 10K 25T	
R4	1	629669	POT. 10K 1T	
R3	1	629669	POT. 10K 1T	
R2	1	054033	POT. 10K 25T	
R1	1	054033	POT. 10K 25T	
J8 ↓ J1	24	623911	MALE JUMP, SINGLE WIDE	
J8 ↓ J1	8	620637	FEMALE JUMPER	

ITEM	QTY	COMPUTER NO	DESCRIPTION	PART NO.
CR8	1	081004	DIODE	IN4004
CR7	1	081004	DIODE	IN4004
CR6	1	081004	DIODE	IN4004
CR5	1	081004	DIODE	IN4004
CR4	1	081004	DIODE	IN4004
CR3	1	081004	DIODE	IN4004
CR2	1	081004	DIODE	IN4004
CR1	1	081004	DIODE	IN4004
C17	1	067001	CAPACITOR, POLY 1.0μF	
C16	1	062008	CAPACITOR CER 0.1μF	
C15	1	062008	CAPACITOR, CER 0.1μF	
C14	1	063007	CAPACITOR, TANT 10μF	
C13	1	063007	CAPACITOR TANT 10μF	
C12	1	062014	CAPACITOR, CER 1.0μF	
C11	1	062008	CAPACITOR, CER 0.1μF	
C10	1	062008	CAPACITOR CER 0.1μF	
C9	1	063007	CAPACITOR, TANT 10μF	
C8	1	062008	CAPACITOR, CER 0.1μF	
C7	1	062008	CAPACITOR CER 0.1μF	
C6	1	062008	CAPACITOR, CER 0.1μF	
C5	1	062008	CAPACITOR, CER 0.1μF	
C4	1	062008	CAPACITOR, CER 0.1μF	
C3	1	062008	CAPACITOR, CER 0.1μF	
C2	1	062014	CAPACITOR, CER 1.0μF	
C1	1	063007	CAPACITOR, TANT 10μF	
3	3	175007	SOCKET, 24 PIN DIP	
2	6	175004	SOCKET, 14 PIN DIP	
1	1	662402	PRINTED CIRCUIT BOARD	471112

SYM	DATE	CHANGE	BY
A			
B			
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D			

MATERIAL

THERMOTRON CORP.
HOLLAND, MICHIGAN U.S.A.

DRAWN BY	DATE	SCALE	APPROV.
[illegible]	2/18/85	1:1	

DESCRIPTION: PCB ASSEMBLY - T200 STAGING BD.

FOR

DRAWING NO. 471111 Y

ITEM	QTY	COMPUTER NO.	DESCRIPTION	PART NO.
XR6	1	657905	DIODE, LED - YELLOW	
XR5	1	657905	DIODE, LED - YELLOW	
XR4	1	081017	DIODE, LED - GREEN	
XR3	1	081017	DIODE, LED - GREEN	
XR2	1	081015	DIODE, LED - RED	
XR1	1	081015	DIODE, LED - RED	
VR1	1	081036	DIODE, ZENER	LM329
U9 U4	6	093019	I.C.	LM324N
U3	1	658030	RESISTANCE PROGRAM BOX	471092
U2	1	658057	RESISTANCE PROGRAM BOX	471094
U1	1	658049	RESISTANCE PROGRAM BOX	471093
TP16 TP1	16	640077	J-PIN	
TB3	1	658073	TERMINAL BLOCK, 12 POS.	4PCV-12
TB2	1	657794	TERMINAL BLOCK, 7 POS.	3PCV-07
TB1	1	666297	TERMINAL BLOCK, 3 POS.	3PCV-03
SW2	1	658013	SWITCH, DIP 8 POS.	
SW1	1	658013	SWITCH, DIP 8 POS.	
SSR6 SSR1	6	658081	SOLID STATE RELAY	GA8-2801
R62	1	051082	RESISTOR, 15M 5%	
R61	1	052401	RESISTOR, 10K 1%	
R60	1	052401	RESISTOR, 10K 1%	
R59	1	052301	RESISTOR, 1K 1%	

ITEM	QTY	COMPUTER NO.	DESCRIPTION	PART NO.
R58	1	051082	RESISTOR, 15M 5%	
R57	1	051082	RESISTOR, 15M 5%	
R56	1	052601	RESISTOR, 1M 1%	
R55	1	052301	RESISTOR, 1K 1%	
R54	1	052530	RESISTOR, 200K 1%	
R53	1	052301	RESISTOR, 1K 1%	
R52	1	052418	RESISTOR, 15K 1%	
R51	1	052401	RESISTOR, 10K 1%	
R50	1	052401	RESISTOR, 10K 1%	
R49	1	052401	RESISTOR, 10K 1%	
R48	1	052401	RESISTOR, 10K 1%	
R47	1	052301	RESISTOR, 1K 1%	
R46	1	052301	RESISTOR, 1K 1%	
R45	1	052401	RESISTOR, 10K 1%	
R44	1	051082	RESISTOR, 15M 5%	
R43	1	052401	RESISTOR, 10K 1%	
R42	1	052401	RESISTOR, 10K 1%	
R41	1	051082	RESISTOR, 15M 5%	
R40	1	052401	RESISTOR, 10K 1%	
R39	1	052301	RESISTOR, 1K 1%	
R38	1	052301	RESISTOR, 1K 1%	
R37	1	052401	RESISTOR, 10K 1%	
R36	1	051082	RESISTOR, 15M 5%	
R35	1	052401	RESISTOR, 10K 1%	
R34	1	052401	RESISTOR, 10K 1%	
R33	1	051082	RESISTOR, 15M 5%	
R32	1	052401	RESISTOR, 10K 1%	
R31	1	052430	RESISTOR, 20K 1%	
R30	1	052430	RESISTOR, 20K 1%	
R29	1	052401	RESISTOR, 10K 1%	
R28	1	052518	RESISTOR, 150K 1%	
R27	1	052601	RESISTOR, 1M 1%	
R26	1	052601	RESISTOR, 1M 1%	

ITEM	QTY	COMPUTER NO.	DESCRIPTION	PART NO.

SYM	DATE	CHANGE	BY
A			
B			

SYM	DATE	CHANGE	BY
C			
D			

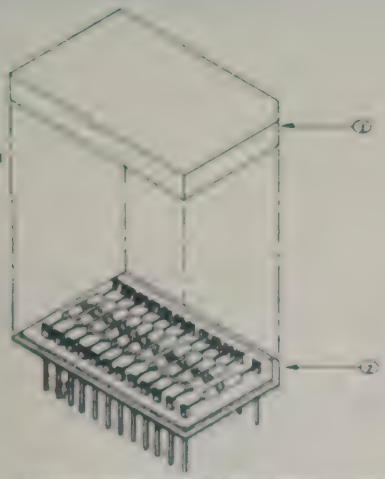
MATERIAL

THERMOTRON CORP.
HOLLAND, MICHIGAN U.S.A.

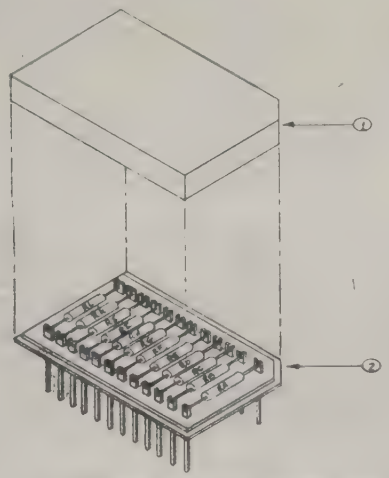
DRAWN BY	DATE	SCALE	APPROV.
MT	2/18/83	1:1	

DESCRIPTION: PCB ASSEMBLY- 5200 STAGING BD.

DRAWING NO 471111



RL			RESISTOR
RK			
RJ			
RI			
RH			
RG			
RF			
RE			
RD			
RC			
RB			
RA			RESISTOR
2	657832		DIP PLUG
1	657840		DIP COVER



1	RL		RESISTOR
1	RK		
1	RJ		
1	RI		
1	RH		
1	RG		
1	RF		
1	RE		
1	RD		
1	RC		
1	RB		
1	RA		RESISTOR
1	2	657832	DIP PLUG
1	1	657840	DIP COVER

1	RL		RESISTOR
1	RK		
1	RJ		
1	RI		
1	RH		
1	RG		
1	RF		
1	RE		
1	RD		
1	RC		
1	RB		
1	RA		RESISTOR
1	2	657832	DIP PLUG
1	1	657840	DIP COVER

1	RL		RESISTOR
1	RK		
1	RJ		
1	RI		
1	RH		
1	RG		
1	RF		
1	RE		
1	RD		
1	RC		
1	RB		
1	RA		RESISTOR
1	2	657832	DIP PLUG
1	1	657840	DIP COVER

1	RL		RESISTOR
1	RK		
1	RJ		
1	RI		
1	RH		
1	RG		
1	RF		
1	RE		
1	RD		
1	RC		
1	RB		
1	RA		RESISTOR
1	2	657832	DIP PLUG
1	1	657840	DIP COVER

1	RL		RESISTOR
1	RK		
1	RJ		
1	RI		
1	RH		
1	RG		
1	RF		
1	RE		
1	RD		
1	RC		
1	RB		
1	RA		RESISTOR
1	2	657832	DIP PLUG
1	1	657840	DIP COVER

1	RL	652421	RESISTOR
1	RK	652421	
1	RJ	652421	
1	RI	652421	
1	RH		OPEN
1	RG	652401	
1	RF	652410	
1	RE	652410	
1	RD	2	4.7
1	RC	2	4.7
1	RB	2	4.7
1	RA	2	4.7
1	2	657832	DIP PLUG
1	1	657840	DIP COVER

NOTES:
1. ALL RESISTORS ¼W 1% UNLESS OTHERWISE NOTED
2. SOLDER RESISTORS DOWN (24 PL)
3. GLUE COVER DOWN
4. WRITE RN. ON STICKY LABEL AND STICK ON COVER

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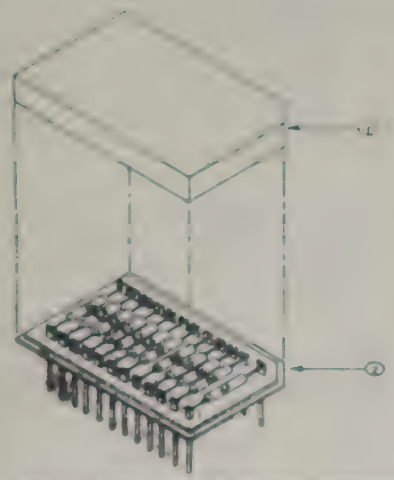
THERMOTRON INDUSTRIES

PROGRAMMABLE RESISTANCE BOARD



		RESISTOR	
		RESISTOR	
	2	467832	DIP PLUG
	1	467840	DIP COVER

		RESISTOR	
		RESISTOR	
	2	467832	DIP PLUG
	1	467840	DIP COVER

		RESISTOR	
		RESISTOR	
	2	467832	DIP PLUG
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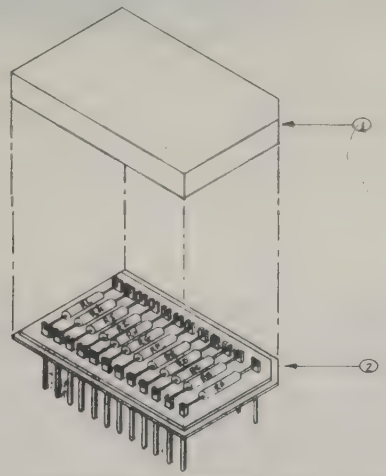
	1	467840	DIP COVER

		RESISTOR	
		RESISTOR	
	2	467832	DIP PLUG
	1	467840	DIP COVER

NOTES:
1. ALL RESISTORS ¼W 1% UNLESS OTHERWISE NOTED
2. SOLDER RESISTORS DOWN (24 PL)
3. GLUE COVER DOWN
4. WRITE P/N ON STICKY LABEL AND STICK ON COVER

RELEASED

RELEASED



1	RL		RESISTOR
1	RK		
1	RJ		
1	RI		
1	RH		
1	RG		
1	RF		
1	RE		
1	RD		
1	RC		
1	RB		
1	RA		RESISTOR
1	2	657832	DIP PLUG
1	1	657840	DIP COVER

1	RL		RESISTOR
1	RK		
1	RJ		
1	RI		
1	RH		
1	RG		
1	RF		
1	RE		
1	RD		
1	RC		
1	RB		
1	RA		RESISTOR
1	2	657832	DIP PLUG
1	1	657840	DIP COVER

1	RL		RESISTOR
1	RK		
1	RJ		
1	RI		
1	RH		
1	RG		
1	RF		
1	RE		
1	RD		
1	RC		
1	RB		
1	RA		RESISTOR
1	2	657832	DIP PLUG
1	1	657840	DIP COVER

1	RL		RESISTOR
1	RK		
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1	RE		
1	RD		
1	RC		
1	RB		
1	RA		RESISTOR
1	2	657832	DIP PLUG
1	1	657840	DIP COVER

1	RL		RESISTOR
1	RK		
1	RJ		
1	RI		
1	RH		
1	RG		
1	RF		
1	RE		
1	RD		
1	RC		
1	RB		
1	RA		RESISTOR
1	2	657832	DIP PLUG
1	1	657840	DIP COVER

1	RL		RESISTOR
1	RK		
1	RJ		
1	RI		
1	RH		
1	RG		
1	RF		
1	RE		
1	RD		
1	RC		
1	RB		
1	RA		RESISTOR
1	2	657832	DIP PLUG
1	1	657840	DIP COVER

1	RL	052481	RESISTOR
1	RK	052469	
1	RJ	052457	
1	RI	052445	
1	RH		
1	RG		
1	RF	052433	
1	RE	052421	
1	RD	052469	
1	RC	052409	
1	RB	052497	
1	RA	052385	RESISTOR
1	2	657832	DIP PLUG
1	1	657840	DIP COVER

NOTE:
1. ALL RESISTORS ⅛W 1% UNLESS OTHERWISE NOTED
2. SOLDER RESISTORS DOWN (24 PL)
3. GLUE COVER DOWN
4. WRITE P.N. ON STICKY LABEL AND STICK ON COVER

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THERMOTRON IND
PROGRAM
RESISTOR

SPARE PARTS AND RETURN OF MATERIALS

SPARE PARTS:

Thermotron does not recommend that you keep a supply of parts on hand because the nature of any failure is random. If there were patterns to failures, design changes would have been made. However, a complete listing of parts is provided.

RETURN OF MATERIALS:

In the event that you have a Thermotron instrument that has failed under warranty, or an instrument which requires repair, call the Controls Department at Thermotron. You will be given an R.M.T. (Return Material Tag) number and authorization for the return of the item. The number should be marked boldly on the outside of your package as well as recorded on your packing slip. When contacting the Controls Department, the following information is required:

1. The complete part number.
2. The model number and serial number, if available, of the Thermotron instrument.
3. The specific complaint regarding failure.
4. A purchase order number is preferred and, in many cases, required.

A telephone number and contact person should be listed on your packing slip so that we know who to contact in case of a question. For warranty replacement, you will be invoiced upon the date of shipment, and you will be issued credit on that invoice upon our receipt of the defective item.

IT IS IMPORTANT THAT YOU IDENTIFY THE ITEM WITH THE R.M.T. NUMBER WHICH IS ASSIGNED.

Warranty service is provided without charge; non-warranty service is done on a time-plus-material basis.

Please address the shipment and any related paperwork to:

THERMOTRON INDUSTRIES, INC.
ACS Factory Service
Kollen Park Drive
Holland, MI 49423
Phone: (616) 392-1491

5200 SYSTEM DISPLAY OPTION

1.0 GENERAL DESCRIPTION

The 5200 display option consists of a rack mounting panel, a circuit board, and switches and potentiometers. Digital data and power is received from the main controller board via a ribbon cable which terminates at connector P1. Analog data terminates at a terminal strip. Two additional terminal strips are provided for display unit interconnections.

When this unit is provided, the controller set point is selected by a three-position switch. In the LOCAL position; the set point is provided by a set point pot provided with the unit. In the REMOTE position; the set point is provided from another local source such as a set point programmer. In the I/O position, the I/O option must be provided, and set point is via a remote host computer.

A four-position switch selects the input to the L.E.D. display. The temperature (switch selectable °F or °C), the setpoint, the ± deviation, or ± % output may be selected for display.

2.0 SPECIFICATIONS

-Display:	Liquid crystal type 4½ digit Large .8 inch high display
-Display Selection Switch:	4 position rotary switch Selects temp. set-point, deviation, or percent output
-Set-point Selection Switch:	3 position rotary switch Selects local, I/O or remote setpoint
-Units Switch:	Toggle switch selects system units to be degrees F or C
-Local Set-Point:	10 turn locking potentiometer
-Inter-Connections:	Analog 5200/display inter-connect -7 terminal T.B. Digital 5200/display inter-connect -10 line flat cable Display inter-connections -(2) 7 terminal T.B.'s
-Power	Derived from the main board
-Dimensions:	5 inches wide 6 inches high 1.75 inches deep

3.0 TERMINAL BLOCK IDENTIFICATION

The terminal blocks are used as follows. See drawing 471118 for placement and numbering of the components. See the 5200 front panel assembly and interconnect drawing 471167 for interconnections.

Terminal Block 1 (TB1)

1 - Digital ground
2 - Display selection line 1
3 - Digital ground
4 - Display selection line 2
5 - Digital ground
6 - Units F/C selection line
7 - Digital ground

Terminal Block 2 (TB2)

1 - V exitation (+5.000 VDC)
2 - Set point to 5200
3 - Analog ground
4 - Set point from I/O
5 - Analog ground
6 - Set point from remote
7 - Analog ground

Terminal Block 3 (TB3)

1 - Local pot high (C.W.) side
2 - Local pot center tap
3 - Local pot low (C.C.W.) side
4 - Set point switch common
5 - Set point switch local input
6 - Set point switch I/O input
7 - Set point switch remote input

4.0 CIRCUIT DESCRIPTION:

This section briefly describes the function of the display board. Refer to drawings 471128 and 471100 for help in understanding the circuitry.

4.1 ANALOG SET-POINT SWITCH NETWORK

The terminal blocks 2 and 3 provide convenient tie-down points for the set-point selection circuitry. The rotary switch selects one of three possible set points. The local set point is generated on the display panel, and terminals are provided to connect it to the 5200.

4.2 DIGITAL DISPLAY CIRCUITRY

The only I.C. on this board, U1, is a serial input L.C.D. driver chip. All functions necessary to drive the 4½ digit display are provided on this chip. Data for the display is fed into the chip through the data-in line, and latched in the chip by the clock line. See the schematic for serial sequence of events which capture the data for the display. R3 and C3 provide filtering for the L.C.D. backplane oscillator. C1 and C2 provide power filtering, which comes from the main board. R1 and R2 are used as bus terminators for the data lines from the 5200. The 10 conductor flat cable from the 5200 system provides data and power to derive information for the display. Terminal block 1 is an interconnect block for wiring to the rotary display selection switch, and also to the °F/°C units selector. J1 selects the clock colon in position 1, and the over-range arrow in position 2. J2 selects the decimal point to be in position 1, 2, 3, or 4 on the L.C.D. corresponding to J2 selection of position 1, 2, 3, or 4.

NOTE: When the Display option is used, be sure the dip switch SW1 on the main board positions 1, 2, 3 are all in the (1) position.

5.0 ALIGNMENT AND CALIBRATION PROCEDURE

Equipment Needed:

-Thermocouple potentiometer
-Jumper clip

The display option should be calibrated after the main board is calibrated. Due to analog offset errors on the main board, the temperature and the set-point to the L.C.D. display should be zero and spanned to insure exact readings.

1. With dip switch (SW1) on the main board positions 1, 2, and 3 to position 1, connect the display board to the main board with the 10 line flat cable.

2. Connect the thermocouple pot to the main board TB1-1 and 2.

3. Connect TB1-10 and TP3 on the main board with the jumper clip.

4. Provide power to the main board.

5. Place the units switch on the display board in position °F or °C to match the units of the T/C pot. (°F provides a finer calibration).

6. Dial in 25% of span on the T/C pot (about -29°F)

7. Select TEMP mode on the display selection rotary switch on the front panel.

8. Adjust R103 on the main board so the T/C pot and the display match.

9. Select S.P. (set point) mode on the display selection rotary switch on the front panel.

10. Adjust R98 on the main board so the T/C pot and the display match.

11. Dial in 75% of span on the T/C pot (about +271°F)

12. Select TEMP mode on the display.

13. Adjust R116 on the main board so the T/C pot and the display match.

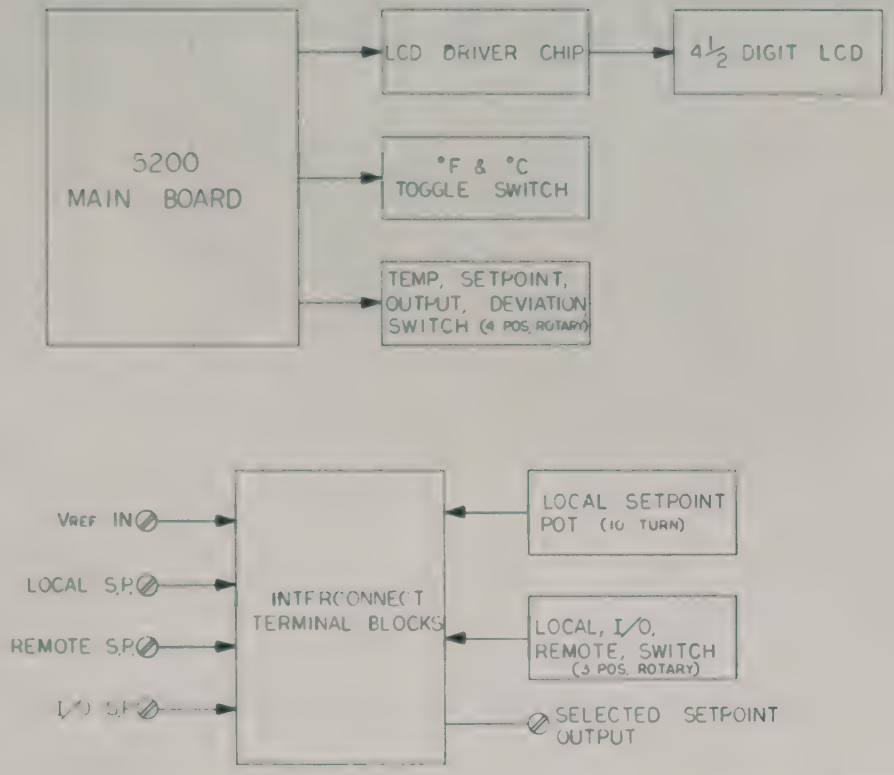
14. Select S.P. mode on the display.

15. Adjust R117 on the main board so the T/C pot and the display match.

16. Repeat steps 6-15 until both zero and span coincide without further adjustments. Try a few spots in mid-range

by changing the T/C pot, and check for agreement between T/C pot and display.

17. Remove jumper and T/C pot, and install display board.



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PARTS LIST

THERMOTRON INDUSTRIES
A.C.S. DIVISION
HOLLAND, MI 49423

FUNCTIONAL BLOCK DIAGRAM
PI 5200 DISPLAY BOARD

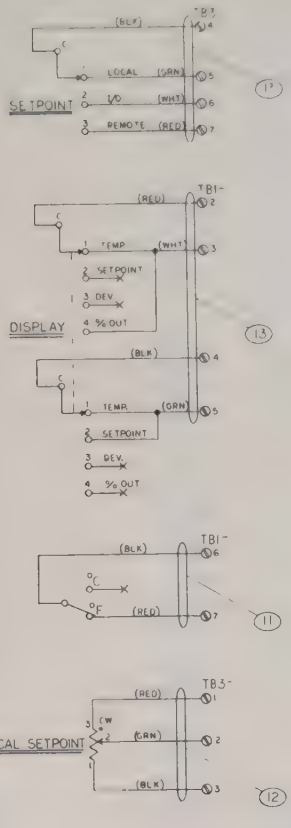
SIZE C | DWG. NO. 471128 | REV.

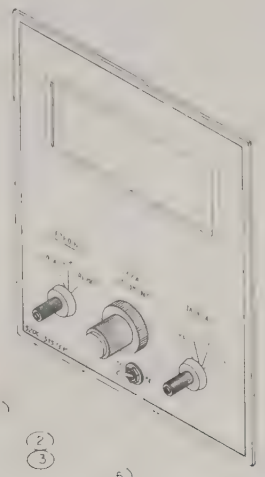
SCALE | SHEET 1 OF 1

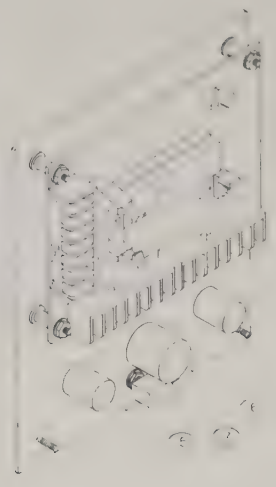
DO NOT SCALE DRAWING

APPLICATION

DWG NO. 471128 REV 1-1







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	194003	WIRE, 22 AWG, 4 COND, 6 LONG	
	194002	WIRE, 22 AWG, 3 COND, 6 LONG	
	194001	WIRE, 22 AWG, 2 COND, 6" LONG	
	272004	WASHER, FLAT	
	279002	SPACER, NYLON	
	114003	NUT, HEX	
	101023	SWITCH, TOGGLE	
	FW336	POTENTIOMETER CONT K 10T	
	193001	SWITCH, ROTARY	
	662417	PCB ASSY, 5200 LCD DISPLAY BOARD	
		KNOB LOCK BLACK MAT FINISH	
		KNOB BLACK MAT FINISH	
		WLP AT FACEPLATE 5200	

THERMOTRON CORPORATION
HOLLAND, MICHIGAN 49423

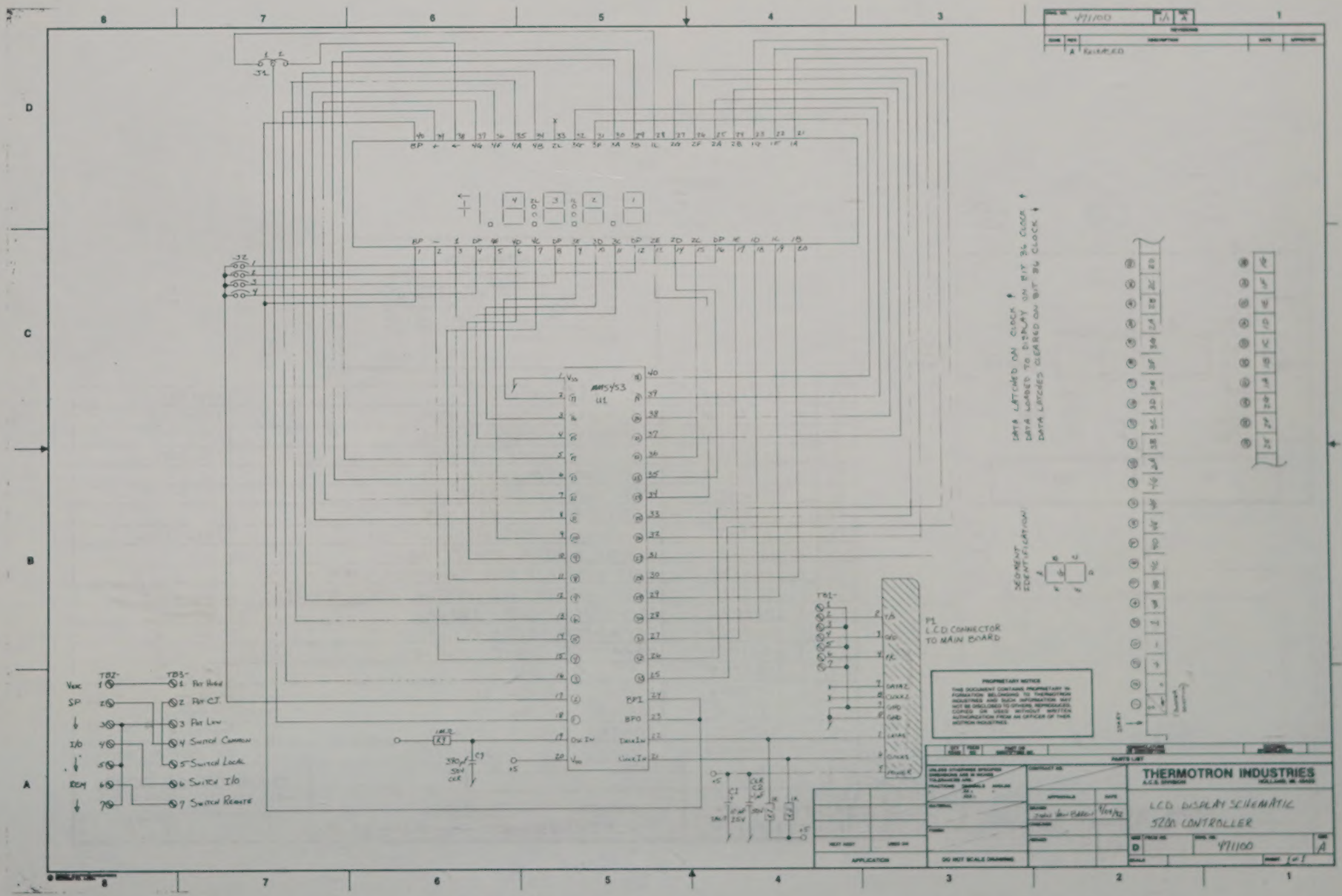
NO	CHANGES	DATE	BY	CHK'D

NO	CHANGES	DATE	BY	CHK'D

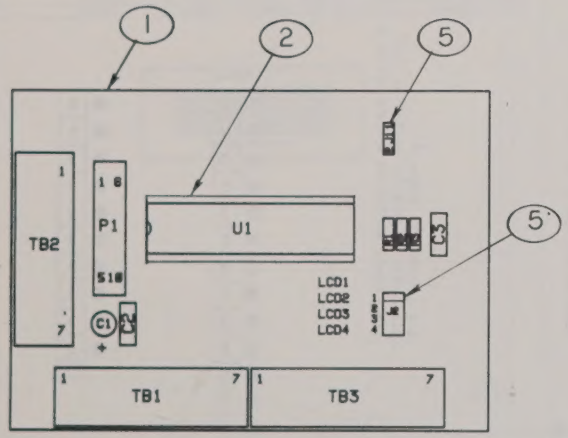
TOLERANCE
SCALE
MATERIAL
FINISH
DRAWN BY
CHECKED BY
RELEASED BY

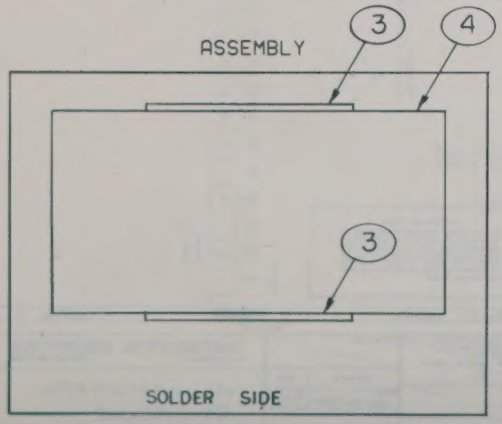
DESCRIPTION
5200 CONTROLLER
FRONT PANEL ASSY
& INTERCONNECT

DRAWING NO
SIZE W


971100
A
Released
J1
J2
MM5453
U1
DATA LATCHED ON CLOCK ↓
DATA LOADED TO DISPLAY ON BIT 24 CLOCK ↑
DATA LATCHES CLEARED ON BIT 24 CLOCK ↓
SEGMENT IDENTIFICATION
P1
L.C.D. CONNECTOR
TO MAIN BOARD
TB1-
TB2-
TB3-
Vac
SP
I/O
REM
1 Pot High
2 Pot CT
3 Pot Low
4 Switch Common
5 Switch Local
6 Switch I/O
7 Switch Remote
DATA1
CLOCK1
GND
LATCH1
CLOCK2
LATCH2
DATA2
BP1
BP0
DataIn
ClockIn
PROPRIETARY NOTICE
THERMOTRON INDUSTRIES
LCD DISPLAY SCHEMATIC
5200 CONTROLLER
971100
D
A
1 of 1

COMPUTER NO.
662437





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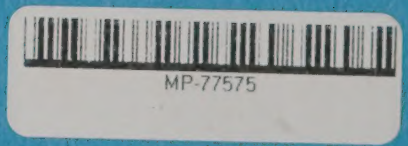
ITEM	QTY	COMPUTER NO.	DESCRIPTION	PART NO.
U1	1	657999	I.C., LCD DRIVER	MM5453
TB3	1	657808	TERMINAL BLOCK, 7 POS.	3PCV-07
TB2	1	657808	TERMINAL BLOCK, 7 POS.	3PCV-07
TB1	1	657808	TERMINAL BLOCK, 7 POS.	3PCV-07
R3	1	052601	RESISTOR, 1M, .25W, 1%	
R2	1	052301	RESISTOR, 1K, .25W, 1%	
R1	1	052301	RESISTOR, 1K, .25W, 1%	
P1	1	657972	HEADER, 10 POS. STRAIGHT	3446-2302
5	2	620637	FEMALE JUMPER, CONNECTOR	
J2	1	629782	MALE JUMPER, 2 WIDE, (CONNECTOR STRIP, 4 POS.)	
J1	1	623911	MALE JUMPER, (CONNECTOR STRIP, 3 POS.)	
C3	1	062020	CAPACITOR, CER 390 pF	
C2	1	062008	CAPACITOR, CER 0.1 µF	
C1	1	063007	CAPACITOR, TANT 10µF 25V	
4	1	666289	LCD, 4 ½ DIGIT	3912
3	2	658006	SOCKET, 20 PIN SIP	
2	1	175034	SOCKET, 40 PIN DIP	
1	1	662429	PRINTED CIRCUIT BOARD	471119

SYM	DATE	CHANGE	BY	SYM	DATE	CHANGE	BY
A				C			
B				D			

MATERIAL: AS NOTED

THERMOTRON CORP.
HOLLAND, MICHIGAN U.S.A.

DRAWN BY	DATE	SCALE	APPROV.	DESCRIPTION	FOR	DRAWING NO.	SIZE
Y.B	2/18/83	1:1		PCB ASSEMBLY - 5200 LCD BOARD		471118	Y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